

Zitteliana 91

An International Journal of Palaeontology and Geobiology



15th Annual Meeting of the European Association of Vertebrate Palaeontologists Munich, Germany

1st to 3rd August 2017

Information and Abstracts



Munich 2017

Zitteliana 91

An International Journal of Palaeontology and Geobiology



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The Making of EAVP 2017

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Host

GeoBio-Center^{LMU}, Richard-Wagner-Str. 10, D-80333 Munich, Germany

Venue

Palaeontological Museum Munich / Department of Earth and Environmental Sciences, Palaeontology & Geobiology / Bavarian State Collection of Palaeontology and Geology (Bavarian Natural History Collections)
Richard-Wagner-Str. 10, D-80333 Munich, Germany

Environmentally Sustainable Conference Management

EAVP 2017 is dedicated to the promotion of environmentally sustainable conference management. In order to keep the carbon footprint as low as possible many crucial aspects concerning venue, transport, catering, and equipment have been considered. Abstaining from merchandising articles was one of the core concerns, too.

Sponsors and Partners



FAKULTÄT FÜR GEOWISSENSCHAFTEN



RO 1197/9-1

Welcome GeoBio-Center^{LMU}



Dear Delegates,

As your hosts for the next few days, we sincerely welcome you to the 15th Annual Meeting of the European Association of Vertebrate Palaeontologists (EAVP 2017) at the Palaeontological Museum of Munich, which is also home to the Bavarian State Collection of Palaeontology and Geology, as well as the Chair of Palaeontology & Geobiology of the Department of Geosciences at Ludwig-Maximilians-Universität München (LMU). The institutional host is the GeoBio-Center^{LMU}, a collaborative platform to facilitate research in biodiversity and geobiology among scientists from different LMU faculties, the Bavarian Natural History Collections (Staatliche Naturwissenschaftliche Sammlungen Bayerns, SNSB), and other research institutes. Hence, the GeoBio-Center^{LMU} provides transdisciplinary expertise and access to infrastructure that fertilizes and facilitates new approaches at the interface of earth and life sciences. Its overall objective is the advancement of our understanding of past and present interactions between the geo- and biospheres, in preparation for future challenges.

Palaeontology *per se* is a bridging science in the aforementioned sense, that allows for direct insights into past life forms, their diversity, ecology and environments. Thus, we are delighted to provide a meeting location for over 200 delegates of vertebrate palaeontology from institutions of 24 countries from all over Europe and beyond, who are passionate in sharing and discussing their research with the community. More than 200 oral and poster contributions, by over 560 authors, on all subfields of vertebrate palaeontology, will be presented and discussed. Many of those are part of three symposia dedicated to the most recent advances in studying the biology of the extinct cave bear, to the initiation of a planned recurring forum on evolution in fish at EAVP meetings, and to the progress and future of ecomorphology and functional anatomy in vertebrate palaeontology. Plenary speakers Bhart-Anjan Bhullar (Yale University, New Haven, Connecticut, USA), Daniel DeMiguel (Institut Català de Paleontologia, Barcelona, Spain), Anjali Goswami (University College London, UK), Alexandra Housaye (Musée Nationale d'Histoire Naturelle / CNRS, Paris, France), Walter Joyce (University of Fribourg, Switzerland),

Serdar Mayda (Ege University, Izmir, Turkey), and Maria McNamara (University College Cork, Ireland) represent recently established hotspots of vertebrate palaeontology, and introduce their research interests and work groups. A substantial amount of contributions come from student delegates who take advantage of this opportunity to present themselves to the community for the first time. This is evidence of a vibrant young vertebrate palaeologist scene, and the extraordinarily successful promotion of the future of the field.

With its more than 250 years of history in vertebrate palaeontology, Munich is an excellent location for EAVP 2017. Nearby sites like those in the Plattenkalk of the Upper Jurassic or in the molasse deposits were sources for fossil vertebrate remains attracting scientific attention even before Georges Cuvier's systematic palaeontological studies in Paris, among those the first pterosaur ever described. Natural history collections in Munich were first established in 1759. A separate palaeontological section of the State Scientific Collections (today part of the Bavarian State Collection of Palaeontology and Geology) was instituted in 1843, contemporaneously with the first chair in Palaeontology in Germany. Then, Johann Andreas Wagner, curator and professor in one person, had a primary research interest in vertebrate palaeontology (among those, fossils from the Plattenkalk in Solnhofen). The first skeleton of the icon of evolutionary sciences, *Archaeopteryx*, was subject to Carl Albert Oppel's (the then museum's assistant and supernumerary professor of palaeontology) studies in Munich in 1860; much to the dismay of Richard Owen in London, who initiated the acquisition of the specimen by the Natural History Museum to impede support for Charles Darwin's evolutionary theory (1859). Oppel was followed by many more renowned Munich vertebrate palaeontologists (Karl Alfred Zittel, Max Schlosser, Ernst Freiherr Stromer von Reichenbach, Ferdinand Broili, Joachim Schröder, Richard Dehm, Volker Fahlbusch, Peter Wellnhofer, Kurt Heißig), proving that the study of vertebrates has always been a major focus within Munich palaeontology.

Having stated all this, it is most remarkable that never before has Munich seen as many as 200 vertebrate palaeon-

tologists at one time. Hence, the 15th Annual Meeting of the European Association of Vertebrate Palaeontologists is a historical event for this city, and we are very much looking forward to bearing witness to the coming days.

Our sincere thanks go to several institutions which have provided financial, material, and non-material help to the hosting of EAVP 2017 and ultimately made the event possible: the Deutsche Forschungsgemeinschaft (grant RO 1197/9-1), the Bavarian Natural History Collections (Bavarian State Collection of Palaeontology and Geology, Zoological State Collection, Botanical State Collection), and Ludwig-Maximilians-Universität München (GeoBio-Center^{LMU}, Faculty of Geosciences, Palaeontology & Geobiology of the Department of Earth and Environmental Sciences). We are grateful to the fantastic team of helpers, both locally- and internationally-based, who have made EAVP 2017 a reality. Last, but not least, thank you for coming to Munich and for contributing with your research.

Again, a warm welcome from us, and please accept our best wishes for the success of this meeting!

Privatdozentin Dr. habil. Gertrud Rößner

Curator of Fossil Mammals
Bavarian State Collection of Palaeontology
and Geology (SNSB)
Ordinary Member GeoBio-Center^{LMU}

Professor Dr. Gert Wörheide

Chair of Palaeontology and Geobiology, Department of Earth
and Environmental Sciences, LMU München
Director of the Bavarian State Collection of Palaeontology
and Geology (SNSB)
Spokesman GeoBio-Center^{LMU}
Vice-Dean, Faculty of Geosciences, LMU München
Deputy Director, Department of Earth and Environmental
Sciences, LMU München

Privatdozent Dr. habil. Mike Reich

Curator of Fossil Invertebrates and Micropalaeontology
Deputy Director, Bavarian State Collection of Palaeontology
and Geology (SNSB)
Ordinary Member GeoBio-Center^{LMU}

Welcome EAVP

It was the summer of 2000, when the former European Workshop of Vertebrate Palaeontologists (EAWP) first landed on German ground in Karlsruhe. At that time this was a true 'workshop' with a long time for discussions around posters, special meetings and a room for workshops that formed spontaneously (even including a linguistic one!). There were about 50 attendees and thus there was no problem with the organisation. The idea to form the European Association of Vertebrate Palaeontologists (EAVP) was born during this meeting.

Now, after fourteen years as a formal association, we are back in Germany, and it is the third German meeting after Darmstadt 2005 and Berlin 2009. We will meet in the world-famous metropolis, the City of Munich, in the heart of Bavaria in the south of Germany. Historically, palaeontology has been institutionally established here since 1843 as part of the Ludwig-Maximilians University. This institution hosted world famous pioneers of vertebrate palaeontology, such as Karl Alfred von Zittel and Ferdinand Broili.

While political Europe is trying to handle a serious crisis, scientific Europe is coming together. The EAVP is an excellent example of this, as can be concluded from the continuously growing number of participants and nations. Yes, EAVP has become international, but this is also paralleled by a gradual decline of the workshop character, with its fruitful discussions and dissemination of new ideas. Hence, we all know: the larger a meeting, the fewer workshops that are possible without conflicts. Therefore it becomes increasingly important for us in our larger form to take note of the ecological impact of our annual conference – as palaeontologists, we have a long-term understanding of environmental consequences, and it is incumbent on us to act with awareness and responsibility. We therefore in particular commend this year's organisers for their efforts in this regard, with strenuous attempts to utilise reusable materials and locally-sourced produce, wherever possible.

When looking at the schedule of the Munich meeting, the attempt to revitalize the workshop idea becomes evident. It is similar to the meeting in Torino in 2014, but with a larger variety of special sessions, in which we can expect powerful discussions and scientific controversies. With a total of 209 submitted abstracts, this for the organisers is a challenge to manage.

Accordingly, on behalf of the EAVP, we wish to thank Gertrud Rößner and her team of helpers both locally- and internationally-based. The Deutsche Forschungsgemeinschaft has funded the meeting generously. Moreover, we are very grateful to the Bavarian Natural History Collections (Bavarian State Collection of Palaeontology and Geology, Zoological State Collection, Botanical State Collection) and Ludwig-Maximilians-Universität München (GeoBio-Center^{LMU},



Faculty of Geosciences, Palaeontology & Geobiology of the Department of Earth and Environmental Sciences) for their support in multiple ways.

Finally, thanks to the members of the EAVP Board for all the constructive discussions during the preparatory phase of this meeting, and to all of you, dear participants from all over the world, for your decision to attend. It would be great if many of you would decide to become a formal member of the EAVP, in order to demonstrate that scientists have something to say about being united across Europe.

Welcome to all. Let us make this conference a great success – and please don't forget to bring something cool for the auction.

See you there!

Apl. Professor Dr. Eberhard 'Dino' Frey

President of the EAVP

Head of the Department of Geosciences, State Museum of Natural History Karlsruhe, Germany

Ass. Professor Dr. Jeff Liston

Vice President of the EAVP

Yunnan University, Kunming, People's Republic of China
Affiliated BSPG Researcher

Invited Speakers

Bhart-Anjan S. Bhullar

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Developmental Insights into Major Evolutionary Transformations of the Vertebrate Head

Representing as it does the confluence of multitudinous tissues from a variety of embryonic sources and the concentration of specialized structures and functions into a compact space, the vertebrate head is perhaps the single most complex structure in all of animal diversity, and among the most evolutionarily significant. I will argue that we need to view the head as an integrated system, and the skull as an epiphenomenon of the other, earlier-forming tissue. Four examples will serve to illustrate the nonindependence of cranial features during evolution and development. First, the development of the snout in reptiles differs fundamentally between birds and nonavian taxa, and this difference is established early at the level of patterning during the 'phylotypic' stage. Second, we have evidence from a number of morphological sources that the brain is the primary influence on the structure of the skull roof across amniotes and probably across all osteichthyans. Third, lateral to the brain, the jaw adductor musculature is in part integrated with brain and brain cavity development and in part surprisingly independent, particularly along the avian stem. Finally, we have been exploring methods for imaging entire embryos at subcellular resolution and find that, as expected, there are broad-scale patterns in mesenchymal and connective tissue architecture that are likely related to the overall integration of discrete organs in the head. It is important when considering paleontological data in particular to recall that the skull is merely an ossified subset of this pervasive connective tissue.



Alligator embryo

Invited Speakers

Daniel DeMiguel

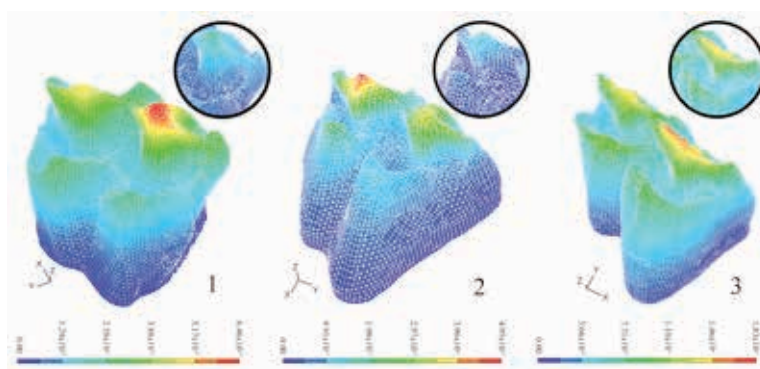
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Fossil Evidence and Tracing Key Innovations – An Example from the Evolution of Ruminant Mammals

We know now that evolution does not proceed as a gradually continuous process. Indeed, accelerations of evolutionary changes are the result of relevant changes. When these changes are not environmental (but concern characteristics of an organism) and permit the performance of a new function that will open a new adaptive zone, they are called key innovations. There are several innovations that acted as triggers of diversification of the Ruminantia, particularly through the Miocene, and we can detect it from direct information of the fossil record. I review and discuss what is known about these evolutionary novelties, with special emphasis on the origin and evolution of cranial appendages and high-crowned dentitions, and present new findings that shed new light on how these traits work. Appendages favored the diversification of pecoran families by being structures strongly related to sexual selection. The acquisition of high-crowned teeth probably expanded potential dietary breadth to allow species to extend diets into the grazing (i.e., abrasive, grass-eating) range without eliminating browsing (or soft, browse-eating) as a potential feeding. When examined together with patterns of ruminant diversity and in the context of climatic changes, the evolution of these innovations is far from being constant and uniform, as cranial appendages and hypsodonty in ruminants occurred through several distinct pulses and varied widely among continents. A first attempt to develop high-crowned dentitions in the early Miocene and a first evolution of appendages (antlers and pronghorns) were interrupted as a consequence of the climate instability associated with the early/middle Miocene transition.



3D finite element models of ruminant teeth showing stress during chewing and biomechanical efficiency.

Invited Speakers

Anjali Goswami

University College London, United Kingdom

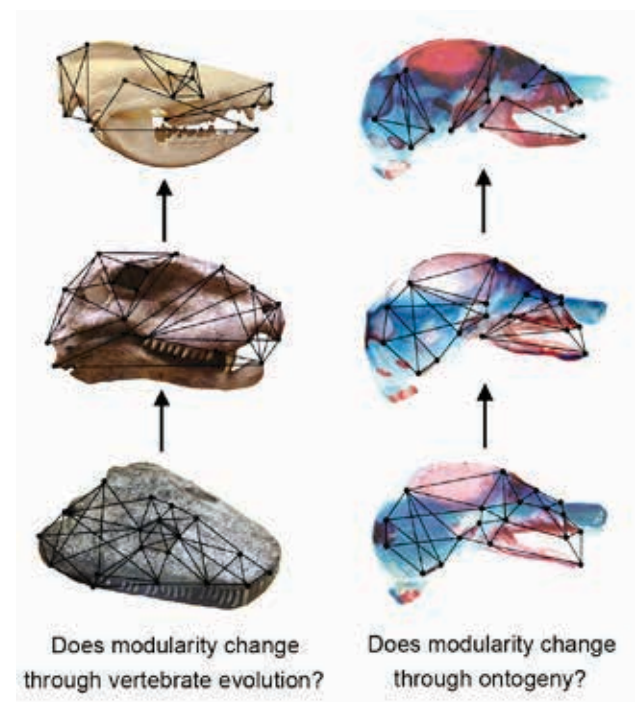
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The Macroevolutionary Consequences of Phenotypic Integration: From Development to Deep Time

Phenotypic integration is a pervasive characteristic of organisms. Interactions among morphological traits, termed phenotypic integration, can be readily identified through quantitative analysis of geometric morphometric data from living and extinct organisms. These interactions have been hypothesized to be a fundamental influence on morphological evolution on small to large time scales. Simulations using covariance matrices derived from landmark data for diverse vertebrate taxa confirm that trait integration can influence the trajectory and magnitude of response to selection. At a macroevolutionary scale, phenotypic integration also produces both more and less disparate organisms than would be expected under random walk models, thereby increasing occupied morphospace range, but also homoplasy and convergence. However, this effect may not translate simply to evolutionary rates.

The role of integration in shaping morphological evolution is particularly interesting when combined with the observation from many studies that cranial integration changes through ontogeny and that postcranial integration is correlated with reproductive strategy in mammals. If integration directs morphological variation, functional pressures at various points in ontogeny may differ in consequence depending in part on level and pattern of integration. For example, high integration in early postnatal ontogeny in marsupials, combined with strong functional pressures for crawling and suckling, may have contributed to the low variance observed in early postnatal marsupials and low disparity across marsupials, relative to placentals. Here, I discuss the macroevolutionary consequences of interactions among phenotypic integration, ontogeny, and function for morphological variance and evolution with comparative data from living and extinct mammals, as well as other amniotes.



Modularity is hypothesized to increase, and overall integration to decrease, through evolutionary and developmental time, with significant implications for the pace and trajectory of morphological evolution.

Invited Speakers

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Between Land And Water – 3D Bone Microanatomical Features of Semi-Aquatic Mammals

The conquest of the aquatic realm has occurred several times independently in various amniote lineages. Adaptation from a terrestrial to an aquatic lifestyle, and thus to a new medium with distinct properties (e.g., viscosity, density), lead to numerous convergences. The musculoskeletal system is naturally affected by this ecological shift. Changes vary pending on the functional constraints the animals have to face, which are notably affected by the dependence to the terrestrial environment, and the swimming mode and depth. Since bone inner structure has been shown to display a strong functional signal and to reflect the constraints an animal faces during its lifetime, it appears as an excellent tool to analyse the initial stages of adaptation to a new environmental context, when anatomical adaptation is not drastic yet. Strong osseous microanatomical specializations are encountered in most exclusively aquatic taxa. They are known to be incompatible with a terrestrial locomotion and thus supposed to occur in exclusively aquatic taxa. Semi-aquatic ones are conversely assumed to display microanatomical features reflecting compromises to various degrees of adaptation to this new media. The present contribution discusses the state of the art relative to stylopod long bone inner adaptation in semi-aquatic mammals. It notably presents results obtained on modern forms illustrating various semi-aquatic lifestyles and locomotor modes, and resulting paleoecological inferences that can be performed on fossil taxa in this ecological shift.

Miocene and a first evolution of appendages (antlers and pronghorns) were interrupted as a consequence of the climate instability associated with the early/middle Miocene transition.



3D segmentation of the cavity system in a femur.

Invited Speakers

Walter G. Joyce

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New Insights from the Fossil Record into the Basal Evolution of Turtles

Turtles have an exceptional fossil record, but surprisingly little was known as recently as 20 years ago about the evolution of basal turtles. Although many evolutionary questions remain far from resolved, new fossils, 3D scanning techniques, and global approaches to phylogeny are providing first glimpses at a cohesive evolutionary history for the group. The purpose of this contribution is to introduce some of the more relevant conclusions that were obtained from my research group and to summarize their impact on the study of turtle evolution. Points of particular interest include: 1) the ability of the earliest turtles with a fully developed shell to protect their heads and necks by ventrolaterally tucking them below the shell; 2) the predominantly terrestrial nature of the stem turtle lineage; 3) the presence of at least three persistent lineages of stem turtles, Helochelydridae, Meiolaniformes, and Sichuanchelyidae, that vicariantly split in the Early to Middle Jurassic due to the break up of Pangea; 4) the evolution of the pleurodiran jaw-closure mechanism from a cryptodiran-like jaw closure mechanism; 5) the vicariant split of crown turtles into three primary lineages, Pleurodira, Cryptodira, and Paracryptodira, also as a result of the break-up of Pangea; and 6) the slow and gradual acquisition of morphological disparity in the skull of turtles throughout their evolution.



Skull of the Late Cretaceous turtle *Gilmoremys lancensis* from Montana (Burpee Museum of Natural History 2013.4.214) (Photo: Joyce).

Invited Speakers

Serdar Mayda

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Mammal Biostratigraphy and Its Relevance for the Interpretation of Anatolian Palaeogeography and Phylogeny of Afro-Eurasian Mammals

Anatolia has functioned as a gateway for mostly European and Asian, partly African faunas during most of its palaeogeographical history. The faunas are known to have exchanged throughout successive migration events from Early Eocene onwards. In this study, I will briefly discuss the Oligocene and Miocene collections from different Anatolian localities that were revisited lately.

A recent paper where the Fossil anguine lizard specimens from several Turkish localities were described, the material from the Thrace Basin localities of Kocayarma (MP 25) and Kavakdere (MP 26/27) represents the oldest known occurrences of anguid lizards not only from Turkey, but also from the whole southeastern Europe. The presence of anguines in the Middle Oligocene of Turkey is consistent with the closing of the Turgai Strait and the establishment of the terrestrial connection between Europe and Asia that opened a dispersal corridor for land dwelling animals. Moreover, new studies on Late Oligocene ruminants and large mammals (rhinocerotoids) collected several Western and Central Anatolian localities including new ectothermic vertebrate results such as *Bavarioboa* and *Ophisaurus* also indicate close terrestrial connections with both Asia and Europe during the late Oligocene and Early Miocene. Finally, the unstudied mammalian collections from Kocayarma (MN25) has revealed the oldest suoid and carnivora of Anatolia, a small palaeochoerid and *Pachycynodon* sp. respectively. Both records proved clear land connections with Europe during Early Oligocene. The new Early Miocene faunal records which were collected from Western and Central Anatolia will be also discussed in terms of palaeogeography and biostratigraphy.



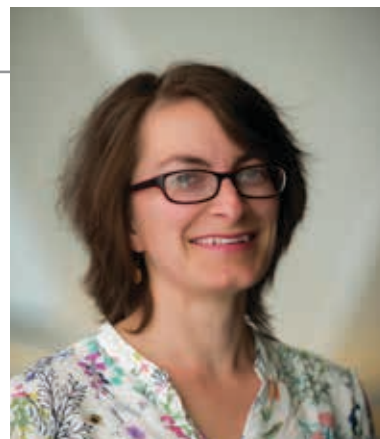
Early Miocene outcrop in Western Anatolia.

Invited Speakers

Maria E. McNamara

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Preservation and Biological Significance of Melanin in Vertebrate Fossils

Melanosomes are micron-scale organelles rich in melanin that commonly occur in integumentary tissues of extant vertebrates. Fossilized melanosomes are associated with the soft tissues of many fossil vertebrates. Previous studies have assumed that the fossil melanosomes originated from the integument and have used the former to infer integumentary coloration and the evolution of visual signalling strategies. Here, I show that melanosomes also occur in various internal tissues in diverse extant taxa representing all higher vertebrate groups. In some taxa, these internal melanosomes vastly outnumber those from the skin and potentially dominate the 'skin shadow' preserved in some fossil vertebrates. Decay experiments and fossils show that internal melanosomes can redistribute within the body during decay. Hence fossil melanosomes may not derive solely from the integument and its appendages and reliably inform on original coloration. It is therefore essential to discriminate between melanosomes from different tissue sources. In some extant and fossil vertebrates, internal and integumentary melanosomes differ in geometry and, in fossils, can occur as discrete layers. Critically, melanosomes from different tissue sources differ in trace element chemistry in extant vertebrates, as do fossil melanosomes from different body regions. Discriminating between integumentary and internal melanosomes requires analysis of melanosome geometry, chemistry and distribution, and is essential for accurate reconstructions of the original colours of fossil vertebrates.



Fieldwork at Jurassic sections in Inner Mongolia.

Pre-Meeting Events

Monday, 31st July 2017, 9am to 5pm

Photogrammetry basics for palaeontologists: A workshop on how to take pictures and create a 3D model

Instructors: Matteo Belvedere, Porrentruy, Switzerland & Heinrich Mallison, Pöttmes, Germany

Photogrammetry as a method to create 3D visualizations has become an integral part of palaeontological research. In this workshop we will teach the basics of data capture, data handling (model creation) in the two most commonly used programs (Reality Capture and Photoscan Pro), and of basic file editing (cleanup, print-readying) in various freely available programs.

Monday, 31st July 2017, 9am to 1pm

Introduction to Finite Element Analysis (workshop sponsored by Transmitting Science)

Instructor: Jordi Marcé-Nogué, Hamburg, Germany

The workshop will introduce vertebrate paleontologists to Finite Element Analysis (FEA), which is a great tool to approach problems in biomechanics of living and extinct organisms using digital models. Key questions in FEA models such as mesh size, boundary conditions, applied forces, scaling, numerical singularities, and, especially, how these models can be used and interpreted in a biological context will be thoroughly addressed using problem-based learning methods by discussing current published papers.

Monday, 31st July 2017, 2pm to 4pm

Neutron Imaging - Information beyond X-rays

Introduction to the ANTARES (Advanced Neutron Tomography And Radiography Experimental System) – facility at Heinz Maier-Leibnitz center of TU München

Referee: Burkhard Schillinger, Garching, Germany

Thermal and fast neutrons can penetrate most metals while delivering high contrast for many light elements, which is often the opposite behavior of X-rays. Hydrogen, i.e. organic materials, can be detected even in lead enclosures. Neighboring elements, even isotopes of the same element, may deliver a very different contrast. X-ray methods are always the first choice for ease of application and availability, but neutron methods are great tools where X-rays fail, not only in cultural heritage. Neutron Imaging has been used with great success for fossils embedded in red beds, i.e. iron containing materials that are impenetrable for X-rays. Fossilized teeth can be classified according to the interface between enamel and dentine, but only some specimens can be examined with X-rays or synchrotron radiation, while others deliver no contrast at all, because some – as yet undetermined – mineral exchange happened in the sediment embedding the fossil. Neutron imaging still delivers large contrast. Fossilized bones in chalk rock or conglomerates like breccia deliver very little contrast to the surrounding material for X-rays, while they can be easily distinguished using neutrons. This information event will show several examples of neutron imaging in palaeontology as well as describe the ANTARES and NECTAR facilities for neutron imaging at the FRM II reactor of Technische Universität München and the free and easy access by short scientific proposals. Enquiries from the audience on suitability of neutron imaging for particular specimens / preservation are especially encouraged and will be discussed.

Monday, 31st July 2017, 4pm to 6pm

Women in palaeontology and ways to address gender disparity in career progression in STEM Roundtable Discussion

Convenors: Femke Holwerda, Munich, Germany; Soledad De Esteban-Trivigno, Cerdanyola del Valles, Spain & Edina Prondvai, Ghent, Belgium

The event will start with a short introduction on gender disparity in STEM, backed by data from scientific studies. After this, experiences and challenges as women in science will be addressed, and propositions and objectives for the future will be discussed. The women's spokesperson of the Faculty of Geosciences of LMU München, Dr. Roswitha Stolz, will moderate the roundtable discussion. **Women AND men** are welcome!

Symposia

Tuesday, 1st August 2017, 1:30pm to 5pm

Recent advances on the palaeoecology, evolution and extinction of the cave bear

Convenors: Anneke H. van Heteren, Munich, Germany & Borja Figueirido, Málaga, Spain

Forty years after the publication of 'The cave bear story' by the vertebrate palaeontologist Björn Kurtén, several aspects concerning the palaeobiology of this Quaternary icon are poorly understood. These aspects are mainly related to its ecological habits such as dietary behaviour, competition with humans, and hybridisation with coeval brown bears. For the symposium, our aims are (i) to bring together all authorities on cave bear biology in order to create an update encompassing the most recent advances in the field, which has been lacking since the publication of Kurtén's book in 1976; (ii) to join efforts among specialists in order to reach a consensus on specific aspects concerning cave bear biology that are still controversial, such as feeding behaviour or extinction, and to define future avenues of promising research; (iii) to discuss this exciting Quaternary subject face-to-face; and (iv) to have an opportunity to acknowledge and celebrate the contributions of Dr. Björn Kurtén to the field of Quaternary Palaeontology.

Wednesday, 2nd August 2017, 8:45am to 5pm

Ecomorphology and functional anatomy in vertebrate palaeontology

Convenors: Josep Fortuny, Paris, France & Cerdanyola del Valles, Spain;

Jordi Marcé-Nogué, Hamburg, Deutschland & Soledad De Esteban-Trivigno, Cerdanyola del Valles, Spain

This symposium intends to be the meeting point for all functional anatomists and evolutionary ecologists interested in vertebrate palaeontology. It aims to offer an occasion for positive research interactions and to discuss the state of the art of ecomorphology, functional anatomy and its perspectives (computational biomechanics, geometric morphometrics, functional approaches, paleobiology, paleoecology). All these topics provide new insights into the tissues that make up the musculo-skeletal system in vertebrates, their functional properties and their function. Moreover, constant methodological improvements and novelties are particularly important in ecomorphology and functional anatomy, implying the use of new and challenging methodologies in vertebrate palaeontology.

Thursday, 3rd August 2017, 9:30am to 5pm

European Fossil Fish Symposium

Convenors: Adriana López-Arbarello, Munich, Germany & Bettina Reichenbacher, Munich, Germany

The European Fossil Fish Symposium is aimed to get together and enhance networking between palaeoichthyologists working in Europe or dealing with European fossil fishes. It welcomes any oral or poster contribution dealing with the evolution of European living and fossil chondrichthyan and osteichthyan fishes (systematics, diversity, biogeography, palaeoecology, taphonomy, etc.). Accordingly, besides any work on European fossil fishes, research on living taxa would be suitable if related to the evolution of European fossil taxa. Similarly, research on fossil taxa outside Europe would be suitable if related to the evolution of living or fossil European taxa. As an exception, presentations from students working in Europe will be accepted even if they are not directly related to European taxa.

Abstracts

The first author is the presenting author, unless otherwise specified (*).

ID 253

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Drones and Dinosaurs: Applications and Implications of 3D GIS in Vertebrate Palaeontology

Oral Presentation

The digital revolution in palaeontology is well underway, yet field recording for broader geological context for a fossil-bearing site is typically relegated to photographs and written notes, without means of cross-referencing with previous excavations. We suggest a thorough workflow for the capture and generation of a 3D, high-resolution, georeferenced, photogrammetric Digital Outcrop Model (DOM), utilising a low-cost Unmanned Aerial Vehicle (UAV). In our example of the continental Maastrichtian site of Pui (Romania), the subsurface geology is digitally represented, accounting for the vertical and horizontal axes as revealed by erosion and excavation, creating a framework for future 3D GIS. Once 3D data file import/export becomes more flexible and easily interchangeable between software, all relevant metric and semantic field data can be incorporated into a 3D geospatial database. This will enable an unprecedented level of communication between fellow fieldworkers, laboratory-based researchers, as well as with the public through citizen science and digital exhibits. An early result of the use of this visual, 3D database is the potential to allow the user to assign individual bones to a single disarticulated skeleton, which may be discovered over many years and by several collectors, allowing for the generation of a virtual quarry map. Once a significant body of data has been accumulated (site dependent), hitherto unknown patterns can be observed in their high-resolution context, which will surely lead to new lines of statistical, taphonomical, and macro-evolutionary research, as well as insights that prompt more efficient avenues for fieldwork and collecting.

ID 142

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Fish Otoliths from the Calabrian-Ionian of Rhodes Island (Southeastern Aegean)

Oral Presentation

European Fossil Fish Symposium

The Teleost fish assemblages of the Calabrian-Ionian southeastern Aegean Sea are reported based on identified otoliths from four outcrops in the northeastern coast of Rhodes Island. Based on our findings, the stratigraphic distribution of twenty-three taxa is extended. The assemblages are mainly composed of members of the families Congridae, Engraulidae, Gonostomatidae, Sternoptychidae, Phosichthyidae, Clupeidae, Scopelarchidae, Gadidae, Sparidae, Gobiidae; Myctophids however are by far the most diverse and abundant group. Overall, the coastal environment is inhabited by small pelagic fish such as anchovies (*Engraulis encrasicolus*), sardines (*Sardinella maderensis*) and horse mackerels (*Trachurus* sp.), and bottom-dwelling gobiids. Occasional and local salinity changes in the freshwater input to the coastal environment allowed the establishment of an *Atherina* population. The pelagic domain contains a well-established and diverse mesopelagic fauna. The deep-water fauna is quite diverse, comprising in most cases gadids (*Gadiculus* spp. and *Micromesistius poutassou*), but also congers, sparids, and carapids. The Pleistocene climatic deterioration is reflected in the fish fauna, through multiple abrupt and gradual replacements in both the coastal-neritic as well the pelagic assemblages. An important note is that the arctic mesopelagic species *Protomyctophum arcticum* is reported here for the first time in the eastern Mediterranean; its presence in the Calabrian stage in Kallithea road section and in the Ionian stage in Lardos section may be indicative of the effect of Pleistocene glacial periods on the fish faunas. Changes in the neritic benthic community are rather few, while the deep-water inhabitants exhibit great stability.

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ID 143

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Fish Otoliths from the Zanclean of Southwestern Peloponnesus (Greece)

Poster Presentation
European Fossil Fish Symposium

The Zanclean teleost fish assemblage of Agia Triada (southwestern Peloponnesus, eastern Ionian) includes mostly Myctophidae, Clupeidae, Sparidae, Gobiidae, Congridae, and Gadidae. In this study, we compare the Agia Triada assemblages with the Zanclean assemblages of the south Aegean Sea (Voutes section, Heraklion, Crete) and the Messinian assemblages of Zakynthos Island also in the eastern Ionian (Kalamaki section) to remark on the implications of the Messinian Salinity Crisis on the eastern Mediterranean fish fauna. Both Zanclean outcrops, in Peloponnesus and on Crete, reveal very rich and diversified assemblages developed during the Zanclean. On the other hand, the pre-evaporitic assemblage of Zakynthos Island contains fewer species. In addition, the fish inhabiting the Ionian Sea just before the Messinian Salinity Crisis mostly were under significant environmental stress, which appears to have suppressed their growth rate, as indicated by the fact that all otolith specimens from Kalamaki were significantly smaller than their equivalent from the Zanclean sections.

This research has been co-funded by the European Social Fund and Greek national funds through the action 'Postdoctoral Research Fellowships' of the program 'Human Resource Development, Education and Lifelong Learning' 2014-2020, which is implemented by the State Scholarships Foundation (I.K.Y.).

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ID 184

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A Piece in the Puzzle of Miocene Palaeobiogeography

Poster Presentation

A fauna of early Middle Miocene age was discovered at the coal mine of Gračanica (Bugojno, Bosnia-Herzegovina).

The ruminants from this locality comprise at least five different taxa: *Dorcatherium vindebonense*, Palaeomerycidae gen. et sp. indet., *Giraffokeryx* sp., *?Tethytragus* sp., *Eotragus ?clavatus*. The assemblage and its evolutionary stage are well in accordance with a fauna of the Mediterranean Neogene Mammal Zones 5/6. Though the remains are sparse, Gračanica essentially contributes to a better understanding of Eurasian migration patterns during the early Middle Miocene. Similar to the Serbian locality Prebreza, Gračanica shows Asian (*Giraffokeryx* sp.) as well as European (*Eotragus ?clavatus*) affinities. Some elements were recorded in European localities as well as in Turkey and Asia (*Dorcatherium*, palaeomerycid, *Tethytragus*). The affinity of the Gračanica fauna to Turkish localities in combination with the record of European faunal elements further confirms the connection of the Balkan Peninsula with Asia Minor providing a corridor between Asia and Europe during this time slice. As the ruminant assemblage from Gračanica comprises only sparse remains, conclusions on the palaeoenvironment are limited. In any case, the ruminant fauna recorded so far from Gračanica fits well with a predominantly forested environment.

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Who killed *Micromeryx*?

Poster Presentation

The rich Middle Miocene locality Sansan (housing nearly 160 vertebrate taxa) is a key locality for the understanding of Miocene ecosystems in Europe. Although much work has been done on the faunal composition of the locality, little is known so far about the taphonomy. New investigations on one of the most abundant large mammal species, the small moschid *Micromeryx flourensianus* Lartet, 1851, give first insights into the taphonomical conditions. While studying the postcranial remains of the species we observed bite marks with a diameter of 2 to 5 mm on the lateral surface of about 50 % of the studied calcanei. In the more abundant astragali we found that more than 50 % of all fragmented specimen were more heavily fragmented on the medial side than on the lateral side and at least 25 % of all fragmented astragali showed bite marks on the medial side similar to the ones observed on the calcanei. From the size of the bite marks, their position, and the body mass of *Micromeryx flourensianus* we conclude that the bite marks are less likely resulting from an attack of a large predator or originate from scavenging on the carcass. Although recorded from the lo-

cality, crocodile remains are very rare in Sansan, and appear less likely as the origin of the rather common bite marks as well. A possible scenario is that the marks originated from a small- to medium-sized predator (size class of e.g. *Styriofelis lorteti*) grabbing the fleeing prey during the hunt.

ID 293

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New Insights on Ancestral Neopterygian Morphology from Computed Microtomography (μ CT)

Oral Presentation
European Fossil Fish Symposium

In contrast to most major gnathostome lineages, the ancestral anatomy of Neopterygii is poorly understood. The quality of the late Paleozoic fossil record and our limited understanding of the endoskeletal anatomy of Paleozoic–early Mesozoic actinopterygians are the most likely causes of this knowledge gap. To ameliorate this situation, we employed μ CT to investigate for the first time the endoskeletal anatomy of two critical fossils associated with the early evolutionary history of Neopterygii, *Brachydegma caelatum* (Artinskian, Texas) and the ‘parasemionotid’ cf. *Broughia* sp. (Induan, East Greenland). *Brachydegma* has been variously aligned with acrolepids, amiiforms, or the neopterygian stem. On the other hand, ‘parasemionotids’ are widely accepted as the earliest crown neopterygians, being often resolved as stem holosteans. μ CT revealed an unusual mosaic of anatomical traits in *Brachydegma*, including: a long parasphenoid stalk; an enclosed aortic canal; a persistent oticooccipital fissure; a dermohyal not fused to the broad-headed hyomandibula; large uncinat processes on the epibranchials; and large clavicles. Collectively, these features suggest that *Brachydegma* is a crownward stem neopterygian rather than a crown neopterygian. Further study of *Brachydegma* will help clarify aspects of character polarity and evolution in early neopterygians. Although ‘parasemionotids’ have been repeatedly studied during the past century, our investigations of cf. *Broughia* sp. revealed characters previously unknown in the group, such as the presence of an enclosed aortic canal, a feature unknown in crown holosteans. Emerging data from Paleozoic taxa like *Brachydegma* are critical for interpreting the placement of ‘parasemionotids’, as well as establishing their coherence as a clade.

ID 208

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Evolution of Living and Fossil Myodont (Mouse-Related) Rodents

Oral Presentation

Living rodents are composed of three radiations: squirrel-related, guinea-pig-related, and mouse-related, with anomaluromorphs and castorimorphs likely related to the mouse-related clade (Myodonta). Abundant fossil remains of these groups and stem relatives, dating to the Paleocene, provide the opportunity to better understand how these major radiations evolved. Here we present a diminutive, articulated skeleton with a skull approximately 17mm in length from the late Eocene of Flagstaff Rim, Wyoming, referable to *Heliscomys* (Geomyoidea). The specimen is embedded in rock but sufficiently distinct from its surrounding matrix to enable virtual CT dissection of the skull and skeleton. The skull exhibits a broad zygomatic plate on either side of its rostrum, a slightly enlarged infraorbital foramen approximately halfway between the upper incisors and root of the maxillary zygoma, elongate incisive foramina, and an angular process of the dentary that is in line with the lower incisor alveolus. The open root of the upper incisor extends posteriorly to a point just dorsal to the roots of P4. The root of the lower incisor curves underneath the lower cheek teeth and terminates in a shelf posterior to the toothrow, close to the mandibular foramen. *Heliscomys* has previously been hypothesized to be related to geomyoid rodents, including extant pocket gophers and kangaroo rats, in addition to Oligocene fossils such as *Florentiamys* and *Gregorymys*. A combination of anatomical and molecular characters across relevant taxa supports *Heliscomys* with geomyoids, close to the mouse-related clade, but it is not yet clear if all fossil ‘geomyoids’ are monophyletic.

ID 141

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3-D Morphology of Pharyngeal Dentition from Recent and Fossil *Capoeta* (Teleostei, Barbinae): Implications for Taxonomy and Phylogeny

*Oral Presentation, Student Contribution
European Fossil Fish Symposium*

The genus *Capoeta* is an herbivorous cyprinid (barbine) group, widely distributed in Western Asian water bodies. Recent species show a distinct biogeographic pattern with endemism to large fluvial drainage basins. The fossil record of *Capoeta* is still largely unknown, mainly based on problems with lower-level taxonomy of isolated pharyngeal teeth. Here we show that the 3-D morphology of recent pharyngeal dentition of this genus provides important traits for identifications at the generic and/or specific levels and has potential phylogenetic signal. Within the genus we describe a substantial heterodonty and identify 18 different shape classes among ten recent *Capoeta* species. We apply our morphologic groups to isolated pharyngeal teeth of *Capoeta* from an early Pliocene locality from eastern Anatolia (Cevirme, Turkey). Taxonomic results are interpreted in terms of palaeogeographic development of Kura-Araks and Euphrates-Tigris drainage systems, which includes drainage capture due to late Neogene geodynamic re-organizations. This study shows, that the combination of traditional morphology and 3-D morphometric methods provides sophisticated results for generic and/or specific level taxonomy of fossil cyprinid fishes, which can be applied further for phylogenetic analyses of barbine fishes.

ID 231

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Ecomorphology and Functional Anatomy in the Giraffe-necked Gazelle (*Litocranius walleri*)

Poster Presentation

The giraffe-necked gazelle or gerenuk is probably the most enigmatic antelope on earth. This medium-sized antelope is closely related to gazelles and springbok. Unlike these, however, it possesses low-crowned teeth and feeds exclusively on browse, especially on fresh *Acacia* leaves that it picks from between the thorns with its long and slender snout. With its long neck and legs it reaches a high feeding range already, but it can further increase it to about 2 m height by standing bipedally. This behaviour is shown frequently, and the animals can even support their body in the upright position without using the front legs to hold on to the vegetation.

The most unusual feature of the gerenuk is the skull. It is comparatively small and flat, bearing extremely heavy horns in males. The braincase is exceptionally elongate, with highly ossified occipital bones in males. This morphology is largely dissimilar to closely-related gazelles. Most striking, however, is the correspondence of the neonate gerenuk skull with that of gazelles: hence, the elongation of its adult cranium is a postnatal process.

Using micro-CT images of juvenile and adult skulls, we aim at understanding this process. We elucidate the postnatal changes that take place in the gerenuk skull compared to the closely related species, and quantify these changes using morphometric methods. We argue that the postnatal changes in the gerenuk skull are functionally related with the specialized feeding posture.

ID 118

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Beyond the Form/Function Paradigm: Biomechanical Modelling and Testing the Limits of Biological Inference

*Oral Presentation
Symposium: Ecomorphology and Functional Anatomy
in Vertebrate Palaeontology*

Inferences of biological function in extinct taxa are based upon various lines of evidence, but are most frequently deduced using variations on the 'paradigm method'. Observations on the relationship between form and function in extant taxa provide verifiable constraints on the plausibility of potential behaviours and have been widely applied throughout the history of palaeontology. However, the advent of new imaging techniques and quantitative computational biomechanical methods now enables more direct testing of functional hypotheses. These methods, including finite element analysis, multibody dynamics analysis and gait

analysis, permit detailed investigations of function based upon the 3D morphology, geometry and internal anatomy of hard tissues, combined with myological inferences drawn from the extant phylogenetic bracket, thus combining comparative morphological and biomechanical data. All of these techniques provide quantitative outputs that can be tested further via sensitivity analyses and verification against experimental extant models. Application of these methods is beginning to show that although simple form/function comparisons can still make a valuable contribution to understanding the gross function of a structure, they are inadequate for revealing important details when taxa with similar morphologies are compared. This point is illustrated with case studies from dinosaur feeding and locomotion, where convergently acquired, superficially similar, structures are shown to exhibit significant functional differences when examined at varying hierarchical levels.

ID 306

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The relevance of the Spanish Late Jurassic-Early Cretaceous sharks in the European fossil record

Oral Presentation
European Fossil Fish Symposium

Prior to the last decades, the record of fossil sharks from the Upper Jurassic and Lower Cretaceous of Spain was strikingly low, compared to the record of these chondrichthyan faunas in other European countries such as the United Kingdom, France or Germany. The presence of articulated remains assigned to *Hybodus* in the classical fossil-Lagerstätten site of La Pedrera de Rúbies (Lleida, Cataluña), or the presence of the genus *Asteracanthus* in Ortigosa de Cameros (La Rioja) had been relatively ignored by specialists during the twentieth century and the beginning of the present one. Systematic researches for isolated microremains of vertebrates, like the ones done in the area of Galve (Teruel, Aragón) were almost nonexistent until the eighties. Through the nineties until today, at least 6 sites with shark faunas have been discovered from the Upper Jurassic of Spain, and more than 20 from the Lower Cretaceous sediments. Some of the most interesting sites in relation to the European record are located in the Cameros and Basque-Cantabrian Basins. In particular the former one, located in the North of the extensive Iberian Basin, has yielded thousands of isolated hybodont remains, which have proved to be very useful to the better understanding of the dentition patterns and taxonomy of some important taxa of the family Lonchidiidae. This family was highly widespread in Western Europe, and it is one of the most commonly found in the Early Cretaceous non-marine environments of this continent.

ID 239

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Anatomy, Life-History and Phylogeny of an Exceptionally Preserved Hadrosaur from the Judith River Formation of Montana (USA)

Oral Presentation

Complete skeletons of hadrosaurs are not so uncommon in the fossil record, with dozen of specimens being collected in the northern hemisphere. However, just a few of those specimens have associated fossilized skin. Here we present a new hadrosaur 'mummy', nicknamed 'Laura', found at the Udelhoven Ranch (Judith River Formation, Winifred, Montana, USA) in 2001 and prepared in Italy in 2010. The specimen has more than 50% of skeletal material preserved, with only the prementary, some ribs and chevrons, the distal part of the tail, some distal elements in the fore- and hindlimbs missing, and fossilized skin with different recognizable scale patterns that covers the dorsorostral portion of the nasals, part of the rib cage, the left femur, and the proximo-median area of the tail. The individual was old at the moment of death: samples from the tibia and the third dorsal rib head show an extensive amount of remodeling, and at least 6 LAGs. 'Laura' was informally referred to the genus '*Prosaurolophus*' because of its large size, and a small, triangular crest above the eyes. However, it differs from *Prosaurolophus* because of the absence of the lateral excavations on the sides of the crest, an elongated dorsal ramus of the premaxilla (likely longer than the anterior process of the nasal), and a trapezoidal and wide infratemporal fenestra. At the time of writing, a phylogenetic analysis is being performed to assess the position of 'Laura' within the tree of Hadrosauridae.

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ID 203

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A New Fauna from the Oldowan-Acheulean Transition at Olduvai Gorge, Tanzania, and the Paleocology of the Serengeti

Oral Presentation

Eight years of excavation work by the Olduvai Geochronology and Archaeology Project (OGAP) has produced abundant remains of a rich vertebrate fauna from several sites within and just below Middle Bed II, Olduvai Gorge, Tanzania. Study of these as well as the recently re-organized collections from Mary Leakey's 1972 HWK EE excavations here provides a synthetic view of the faunal community of Olduvai at 1.7-c.1.4 Ma. We expand the faunal list for this interval, including naming a new bovid species, clarify the evolution of several mammalian lineages, and record new local first and last appearances. The fossil community supports previous indications for the dominance of open and seasonal grassland habitats at the margins of paleo-Lake Olduvai. No major turnover or paleoecological changes seem to be associated with the transition from Oldowan to Acheulean stone tool technologies within Middle Bed II. The Middle Bed II large mammal community is much more species-rich and includes a larger number of large-bodied species (> 100 kg) than its modern Serengeti analog. By comparison, the Serengeti today fits the profile of a 'downsized' community, similar to those that have been defaunated by human disturbance rather than by climate change. Despite these fundamental differences, trophic network analyses show that the Middle Bed II and extant

Serengeti communities bear similar structural properties as concerns the distribution of feeding links among prey and predator species (including hominins). Both climatic and human-induced hypotheses for the loss of African Pleistocene large mammals require further testing.

ID 289

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Teleosteans from the Maastrichtian (Late Cretaceous) of Northeastern Spain: Contributions to the European Fossil Fish Record

Oral Presentation

European Fossil Fish Symposium

EAVP Annual Meeting Grant award winner

The ichthyofauna from the early and late Maastrichtian beds of the northeastern Iberian plate (Trempe Formation) was exhaustively studied in a work recently published in the journal 'Palaeogeography, Palaeoclimatology, Palaeoecology'. At least eighteen different taxa were identified based on tooth morphotypes and scales, including chondrichthyans, basal actinopterygians and diverse teleosteans. The actinopterygian assemblage is more diverse than those of other Campanian and Maastrichtian localities from Spain. Remarkably, one of the identified teleosteans represents its oldest fossil record worldwide, whereas others show their oldest record in Europe. These fossil records are in agreement with the current phylogenetic and palaeobiogeographical hypotheses. In this presentation, we look more deeply into the significance of these records. Furthermore, teeth were classified within diverse ecomorphotypes, representing several trophic guilds including filter-feeders/micropredators, durophages and piscivores. Abundances of teleosteans in these trophic guilds were also significantly different between early and late Maastrichtian assemblages. From a palaeobiogeographical viewpoint, the Maastrichtian ichthyofauna from northeastern Spain included species with different origins and relationships. Changes in the taxonomic abundance were also observed and related to an environmental change that took place throughout the Maastrichtian.

ID 178

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Photogrammetry and 3D Models: A Way to Mitigate the Problems of Private Fossil Collections

Poster Presentation

Private collections were a great way to safeguard fossil remains years ago, but nowadays the specific legislation of many countries considers them cultural resources and laws force them to be stored in public repositories. However, many interesting and significant specimens remain in private hands. This fact represents a major obstacle for the investigators, who have sometimes restricted access for studying these specimens without the possibility to transport them to their laboratory. In our case, we performed photogrammetry using the software Agisoft Photoscan (v. 1.2.4) in order to study a crocodilian skull kept in a private collection. This technique allows the procurement of a 3D reproduction from the surface of the fossil. At first, pictures were taken 360° around both sides of the specimen, and loaded into Photoscan. The software found common features in each photograph, aligning them in a three-dimensional position. Based on the alignment of the pictures, the software made a dense cloud of the specimen. In order to make these steps easier, pictures were divided in four chunks (right dorsal, right ventral, left dorsal and left ventral) and then realigned together by means of landmarks. After that, the points of the complete dense cloud were fused in triangular polygons forming a mesh with the shape of the specimen. Finally, texture and colours of the original object were superposed on the three-dimensional mesh. The obtained 3D model can be added to a digital collection, and it is also possible to obtain a physical cast from a 3D printer.

ID 228

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Preliminary Report of the Ichthyofauna from Pontils (Middle Eocene, Northeastern Spain)

Poster Presentation
European Fossil Fish Symposium

The fossil site of Pontils (Middle Eocene, Ebro Basin, NE Spain) is placed in a sequence of limestones, marls and lignites representing a transitional continental-to-marine environment. It was discovered in the 1980s, when scarce rodent remains were described from several levels of this locality. Recent field campaigns carried out in 2012 and 2016 collected samples from different stratigraphic levels. About 6800 kg of sediment was processed under screen-washing and this has led to the recovery of abundant still-undescribed material including fishes, reptiles and several

mammal groups. The lowest levels of the sequence of Pontils have yielded relatively abundant continental vertebrate remains (mainly rodents, primates, crocodilians and squamates). In addition, the uppermost levels record a change from continental to marine conditions. In PO-39 scarce marine fish teeth are identified together with terrestrial mammals, whereas in PO-40, on the top of the sequence, fish remains are associated with abundant marine invertebrate shells. A relatively diverse ichthyofauna has been recognized in these two levels. The chondrichthyan assemblage is composed by at least two indeterminate sharks and three rays (*Rhinobatos* sp., *Coupatezia* sp. and another different dasyatoid). Actinopterygians are represented by members of Phyllodontidae, probable pycnodontiforms and other indeterminate neopterygians. Further taxonomic study of chondrichthyans and actinopterygians from Pontils might reveal the presence of additional taxa and it is expected to provide new insights on a poorly known period for these groups in Europe.

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ID 106

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So Close, So Far: Rodent Samples Heterogeneity within the Same Stratigraphic Level

Oral Presentation, Student Contribution

Rodent associations are habitually used in palaeo-environmental inferences. Assuming lateral homogeneity in fossil content within stratigraphic levels, sometimes these inferences are performed using the relative abundances of species included in such associations. Nevertheless, this homogeneity has never been checked empirically in species proportions inside the same fossiliferous level. We compared two samples from T1 level of the Somosaguas fossil site (middle Miocene), which were separated laterally by 30 m. Although both samples show identical faunal composition from a qualitative viewpoint, analysis realized through Monte Carlo randomizations indicated the existence of significant differences in relative abundances of different species between the two samples. These results could be due to 1) different sedimentary behaviour of dental pieces from species due to size disparities; 2) small size of sediment samples combined with high density of fossil remains in level T1 of Somosaguas; 3) differential time averaging related to presence of successive alluvial fans, associated to population changes due to environmental changes during

the Aragonian. Our results show the need of cautiousness when palaeoenvironmental inferences are based on relative abundances of micromammalian species.

ID 162

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Isotopic Tracking of Cave Bear Palaeobiology

Oral Presentation

Symposium: Recent Advances on the Palaeoecology, Evolution and Extinction of the Cave Bear

During the past three decades, isotopic investigations of cave bear skeletal remains have yielded extremely valuable information about the palaeobiology of extinct cave bears. This approach, using carbon and nitrogen stable isotopic ratios in bone collagen as well as carbon and oxygen isotopic ratios in carbonate bioapatite, has been applied to several hundreds of specimens across Europe. Not only did the results of C and N isotopes of adult individuals indicate an essentially herbivorous diet in almost every investigated population, but important isotopic changes occurring during growth allowed us to better understand the role of hibernation, suckling and weaning for this species. C and O isotopes could also document some interesting patterns of changes in foraging patterns due to altitude and climate change. The combination of isotopic and palaeogenetic studies allows to investigate differences through time and between genetically distinct populations. Importantly, such investigations performed on some of the last cave bears showed little dietary changes prior to extinction. Stable isotopic investigations of coeval predators also allowed us to find out which carnivores may have hunted the cave bears or scavenged their carcasses. Despite this progress, some questions remain open, such as the type of dietary adaptation of some Romanian cave bears with unusually high abundances of nitrogen-15. These could correspond to foraging on plants with high nitrogen-15 abundances, with an omnivorous diet, or with a physiological effect. In such cases, new isotopic methods, especially single compound nitrogen isotopic analysis of collagen amino acids, will certainly help to solve these issues.

ID 104

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Form-Function Relationships in the Musculoskeletal System: Implications for the Assessment of Arboreal Locomotion in Fossils

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy in Vertebrate Palaeontology

Arboreal locomotion imposes selective pressures that may affect the evolution of the locomotor apparatus as the limbs have to be mobile to reach across discontinuities yet at the same time need to be able to generate a firm grip. Comparative studies of living and extinct taxa generally allow for inference of locomotor performance in fossils, but this approach is limited if the link between form and function is not based on a previously determined *in vivo* relation between osteology, myology and behaviour.

Here, we present quantitative data on the musculoskeletal anatomy of the limb of two closely related species of Mustelidae and relate the findings to the locomotor habits of each: the semi-arboreal pine marten (*Martes martes*) and the more terrestrial stone marten (*Martes foina*). Muscle mass and fiber length were measured and physiological cross-sectional area (PCSA) was calculated in order to describe the functional properties of the forelimb musculature. The limb bone morphology was quantitatively analysed via 3D geometric morphometrics. Using 2-blocks partial least squares (2B-PLS) analysis, the muscle data were related to the osteological data. The identified trait covariation revealed functional adaptations in the musculoskeletal architecture of the limb that are indicative for arboreal locomotion. By including fossil bones, the present study allows for inference of locomotor performance in extinct animals. Ultimately, this improves our understanding of the history of life, in the course of which arboreality has played a key role.

ID 255

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Preliminary Report on the Squamates from the Middle Eocene locality of Pontils (Spain)

Poster Presentation

Squamates (lizards, snakes and amphisbaenians) are nowadays a highly diverse group of reptiles, but their Paleogene record has been unevenly studied. For instance, southernmost European localities are very scarce and limited so far to the early and late Eocene of the Iberian Peninsula. We report here a preliminary account of the squamates identified at Pontils, a middle Eocene locality from the Ebro basin that contains a moderately diverse assemblage of lizards recovered after screen-washing of

multiple levels. The identified material comprises fragmentary tooth-bearing bones (maxillae and dentaries), skull bones (e.g. a frontal), vertebrae and osteoderms. Most specimens have been recovered from the level Pontils 22, which contains gekkotans, lacertids (possibly two different taxa), anguine anguids and snakes. Pontils 39, in contrast, is the only level that has yielded material of a pleurodont iguanid, possibly corresponding to the widespread genus *Geiseltaliellus*. The lack of amphisbaenians is not surprising because these are missing from all European localities between MP11 and MP15. More intriguing is the lack of glyptosauroid osteoderms, which are a ubiquitous component of Eocene herpetofaunas across Europe. The squamate assemblage from Pontils, together with other ongoing studies on additional contemporaneous Iberian assemblages, will fill a temporal gap in our knowledge of the evolution of the group in this region, and is expected to provide new insights on a poorly known period for this group in Europe.

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ID 139

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Middle Miocene Mammals from the Czujan's Sandpit (Mikulov, Czech Republic)

Poster Presentation, Student Contribution

Czujan's sandpit (Mikulov, Czech Republic) represents a unique locality of middle Miocene mammals, and further is known as the type locality of *Tethytragus stehlini*. Czujan's sandpit is mentioned only occasionally in published sources, however, Neogene mammals from the Mikulov area come from several sites of different stratigraphical age. Therefore it is important to distinguish this specific locality from other fossil sites of Mikulov. The studied material which is housed in the Moravian Museum in Brno, the Regional Museum of Mikulov, Masaryk University and Vienna University shows that this locality is relatively rich in terrestrial vertebrates. Over the approximately 40 years (1936-1974) of its existence, this locality provided at least 53 vertebrate individuals where proboscideans are the most abundant taxa. The fossil faunal list includes in total 13 taxa: Proboscidea: *Zygolophodon turicensis*, *Gomphotherium angustidens*, *Prodeinotherium bavaricum*; Rhinocerotidae: *Brachypotherium brachypus*, *Hoploaceratherium* sp.; Equidae: *Anchitherium*

sp.; Chalicotheriidae: *Anisodon grande*; Suidae: *Conohyus simorrensis*, Cervidae: *Heteroprox larteti*, Bovidae: *Tethytragus stehlini*; Palaeomerycidae indet., Carnivora: *Amphicyon* cf. *major* and Testudines: *Testudo kalkburgensis*. This fossil assemblage stratigraphically corresponds to the middle-late Badenian (Astaracian). Taphonomical features of studied material from fluvial sands and gravels suggest that most of fossil remains are individuals what died in the immediate vicinity of the sedimentation area. One of the pieces of evidence that supports this is that most of the skeletal remains were recovered in anatomical position (e.g., whole skeletons and forelimbs or hindlimbs). By the high biodiversity, we can place this small sandpit as the one of the richest middle Miocene terrestrial fossil sites of Central Europe.

ID 179

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Integrated Evolution of the Neck and Braincase in Early Sauropods

Oral Presentation

The Early-Middle Jurassic boundary (c. 175 Ma) is a key period in the evolution of Sauropodomorpha. Whereas all non-sauropodan lineages disappeared by the end of the Early Jurassic, sauropodan lineages started diversifying and became important components of terrestrial faunas until the K/Pg extinction. Previous studies have demonstrated that key traits associated with sauropod gigantism appeared in a stepwise fashion during the Late Triassic and Early Jurassic. We investigated the evolutionary transformation of the sauropodomorph braincase using discrete anatomical characters. Our results show that sauropod braincases are highly distinct, and occupy a different region of morphospace in comparison to non-sauropodan sauropodomorphs. The transformations in sauropod braincase anatomy happened at a short period of time during the early Middle Jurassic, and are mainly related to the surface attachments of craniocervical musculature. Our data are indicative of the integrated evolution of neck and braincase, with neck elongation in the Late Triassic and Early/Middle Jurassic potentially associated to episodes of skull reduction during the evolutionary history of Sauropodomorpha. This is an indication that the 'head and neck' cascade of gigantism was activated more than once in the evolutionary history of Sauropodomorpha, and encompassed only sauropod taxa in the Jurassic. In this context, as greater body mass increases the amount of energy obtained in the

context of a fully herbivorous diet and provides more protection against predators, independent activations of one of the various cascades of gigantism might have played a role in the differential survival of sauropodomorphs at the Early-Middle Jurassic boundary.

ID 305

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Therapsid Tracks, Scratches and Shallow Burrows (?) from a New Middle to Late Permian German Tracksite

Poster Presentation

The recently discovered trace fossil assemblage of Mammendorf quarry in Saxony-Anhalt, northern Germany, comes from a Middle to Late Permian non-marine succession of sedimentary rocks. Here we focus on the most fossiliferous track horizon which represents one of several centimeter-thin siltstone layers within a unit of gray-white sandstones. This horizon was documented and a large part excavated by the Museum für Naturkunde Magdeburg in July and August 2016. The rippled surface is marked by desiccation cracks of varying density and degree of jointing. Apart from shallow tubular and spiral invertebrate burrows the most abundant type of trace fossils within the excavation horizon are tetrapod scratches which occur either as (a) isolated or footprint-related subparallel scratch marks or (b) about 25-cm-wide roundish structures composed of consecutive overlapping left- and right groups of (five) scratches. In several places roundish to oval interruptions of the siltstone layer occur and in one case the siltstone lamina continues downward-displaced within the underlying sandstone layer. We interpret these structures as shallow tetrapod burrows related to the production of the roundish scratching structures. In proximity to the scratches and burrows we have found ca. 5 cm large imprints with a paw-like morphology that are interpreted as therapsid tracks. Furthermore up to 13 cm long imprints occur, many of them with proportionally longer toes than in the smaller track type. The association of these larger imprints with groups of scratches indicates that among the trackmakers also the producers of the roundish scratching structures and burrows might be found.

ID 166

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New Light on the Systematic Position of the Late Cretaceous Giant Bird *Gargantuavis*

Oral Presentation

The giant bird *Gargantuavis philoinos* Buffetaut & Le Loeuff, 1998, is known from scanty remains from a few Late Cretaceous localities, close to the Campanian/Maastrichtian boundary (about 72 Ma) in southern France and northern Spain. Its systematic position has long been uncertain, although it was considered as a possible basal ornithurine. The recent discovery of a well preserved *Gargantuavis* femur at Montplo-Nord (Cruzy, Hérault, southern France), a site that has already yielded several skeletal elements of that bird, provides important new evidence in this respect. The 23 cm long bone indicates a bird about the size of an emu or cassowary. Its estimated mass, calculated on the basis of minimum circumference of the shaft, is about 50 kg, again similar to that of a large emu or cassowary. Unlike a previously described femur from Villespassans (Hérault, southern France), the new specimen from Montplo-Nord shows a well-preserved distal end, which has important implications for the systematic position of *Gargantuavis philoinos*. In particular, the lateral condyle is subdivided into two 'semicondyles', as in modern birds, unlike the condition in archaic birds, including enantiornithines, in which it forms a single rounded condyle. This supports the idea that *Gargantuavis philoinos* is a basal ornithurine rather than a more archaic form. Possible affinities with *Patagopteryx deferrariisi*, a basal ornithuromorph from the Late Cretaceous of Argentina, have been suggested, but that taxon has an undivided lateral condyle and is therefore less advanced in this respect than *Gargantuavis philoinos*.

ID 177

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The Interplay Between Local Environment, Ecological Shifts and Continental Migrations Shaped Iberian Mammalian Diversity Over Millions of Years

Oral Presentation

The roles of environmental and biotic factors in shaping diversity have mainly been assessed at large evolutionary and taxonomic scales, generally looking at entire clades and continental species pools. We investigate the influence of competition, functional diversity, local and global environmental changes, as well as biogeographic events, on the diversity trends of large mammals in the Iberian Peninsula between 15 and 2 Ma. Importantly, we quantitatively assess multiple diversity models where diversification rates and regional species limit (K) can be modulated by the aforementioned factors. We find that the diversity of large Iberian mammals has been limited over time, with species richness showing marked expansions eventually surpassing a point (K) from where a significant part of the niche is unavailable and the regional species pool undergoes substantial depletion. This upper limit to diversity has fluctuated over time, increasing during episodes of a higher incidence of immigrants—especially from Africa—and dryer conditions. Diversification also fluctuated, increasing in dryer pulses and when faunas showed a larger functional disparity. Functional competition—the degree of clustering of species in the functional space—slightly slowed diversification, but holds just a marginal influence in the system. These results portray a complex and dynamic system where diversity is perpetually imbalanced and at the mercy of the interplay between local and broad-scale factors.

ID 212

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Orbit Anatomy in Carnivorous Mammals

Poster Presentation

In this study, we explore the relationship between the anatomy of the eye orbit in carnivorous mammals (Mammalia, Carnivora) and their ecology such as habitat use and predatory technique. The main objective is to make ecological inferences in two extinct saber-tooth felids, *Homotherium serum* and *Smilodon fatalis* (Felidae; Machairodontinae). In this regard, we took a series of anatomical landmarks with particular emphasis on those that characterize the orbits. The landmarks were taken using a Microscribe G2X and three-dimensional modelling techniques in a sample of

carnivorous mammals. The ecological information for each species was taken from the literature. We used linear regression analysis, as well as multivariate statistical techniques such as principal component analysis or canonical variate analysis. The results indicate that phylogenetic patterning was the main source of variation in all variables. Therefore the morphology of the orbits cannot be considered as a morphological indicator of the activity pattern or the habitat use, at least with the actual data. Our results do not inform us about the ecology of both extinct saber-tooths, but provides new findings on the evolution of the order Carnivora.

ID 134

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New *Megalosauripus* Tracks in the Late Jurassic of Portugal

Poster Presentation

Megalosauripus is one of the most common theropod ichnotaxa in the Late Jurassic and Early Cretaceous. It has been described from several localities in Europe, America, and Asia. After a controversial and still unfinished revision process, only two ichnospecies have been considered valid: *M. uzbekistanicus* and *M. teutonicus*. Recent work on the abundant dinosaur track material excavated on the track-sites from Highway A16 (Canton Jura, NW Switzerland) in the Late Jurassic (Reuchenette Fm., Early–Late Kimmeridgian), has allowed the definition of a new ichnospecies *M. transjuranicus*. During a review of the footprint collection from the Sociedade de História Natural in Torres Vedras (Portugal), several well-preserved theropod tracks from Praia do Porto Barril (Mafrá municipality) were identified as belonging to *Megalosauripus*. A comparison of these tracks with the *Megalosauripus* ichnospecies suggests that they most likely belong to *M. transjuranicus* as they exhibit a striking similarity regarding the large and round first phalangeal pad on the fourth digit (PIV1). A comparison with the mediotype of *M. transjuranicus* through the

software DigTrace highlights the similarities between the tracks of Portugal and Switzerland. Thus, the Portuguese tracks are the first evidence of *M. transjuranicus* outside of Switzerland. The Portuguese tracks come from the Freixial Formation (Tithonian) so they are thus only slightly younger than the Swiss tracks. This confirms the presence of similar large theropods during Late Jurassic times in the Lusitanian Basin and the Jura carbonate platform suggesting that land connections might have existed at some point between these two European areas.

ID 296

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Detection of Two Morphotypes from Long Bones of *Europasaurus holgeri* Using Histological Ontogenetic Stages

Poster Presentation, Student Contribution

Sauropod dinosaurs were the largest and the most successful group of terrestrial tetrapod ever to inhabit the earth. An exception is the basal macronarian dwarf sauropod *Europasaurus holgeri* from Kimmeridgian of northern Germany which is known from >20 individuals and a long ontogenetic series. Previous studies, on the vertebral and the skull osteology of *E. holgeri*, had detected two morphotypes that differ by about 20% in body size. These two morphotypes are not evident in the long bones because of their simple morphology and lack of sutural fusion. The morphotypes may be biologically explained as sexual morphs of a single species, as two sympatric species, or as two populations separated in time. The aim of this study is to detect the two morphotypes in the histology of the growth series of long bones (femur, tibia) in order to test these hypotheses. Using the histological ontogenetic stages (HOS) approach, which compares histology with body size, the two morphotypes are not clearly visible. This may be due to imprecision in bone length estimates because of bone incompleteness. Bone circumference offers an alternative proxy for body size, and circumference correlates well with estimated length, suggesting that imprecise length estimates are not the cause of lack of morphotype separation. Instead, HOS of regular-sized sauropods may be inapplicable to *E. holgeri* because of its divergent histology. New HOS developed just for this dwarf sauropod may provide better resolution.

ID 236

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The Anatomy of *Notochelone* Lydekker, 1889 an Early Cretaceous Protostegid (Testudines) from Australia and Its Bearing on the Origin and Early Evolution of Sea Turtles

Poster Presentation

The skeletal material of *Notochelone* sp. kept at The Natural History Museum in London (NHM) and Queensland Museum (QM) in Brisbane was collected in 1978 from sites in northwestern Queensland. The specimens derive from the Toolebuc Formation and the Allaru Mudstone, which are of middle-late Albian age and were deposited in a restricted shallow offshore marine environment. The NHM and QM collections contain six skulls, together with a number of incomplete shells and isolated bones that have never previously been described. We therefore utilized this material to document the morphology of *Notochelone*, and in particular NHMUK PV R11977, a fully prepared skull and associated shell and axial elements that provides new insights into the anatomy, taxonomy and phylogeny of protostegid sea turtles. Novel cranial and postcranial character states were found to be shared by protostegids and crown chelonoids. In addition, braincase osteology was reconstructed from CT scans – amongst the first undertaken for any protostegid. This new data elucidates the problematic monophyly of advanced sea turtles, which contest the placement of protostegids as either early members of the chelonoid radiation or a completely separate lineage of marine basal cryptodires that manifest extreme convergence on crown sea turtles. Furthermore, molecular clock divergence estimates for the sea turtle crown are highly controversial, being pushed back by more than 35 million years if protostegids are considered to be stem chelonoids. Our phylogenetic reassessment of *Notochelone* confirms this scenario, and suggests that protostegids constitute a sister group to crown-sea turtles in accordance with molecular hypotheses.

ID 279

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A Malacophagous New Species of the Genus *Plesiodymylus* (Dimylidae, Eulipotyphla, Mammalia) from the Lower Miocene of Ribesalbes-Alcora Basin

Poster Presentation

The Ribesalbes-Alcora Basin is an intramontane Neogene area situated in the southern Maestrat (Province of Castelló, East of Spain). The fossil record of these localities contains up to 40 localities and 50 mammal taxa. In addition, the presence of the cricetids *Megacricetodon* and *Democricetodon*, along with the eomyids *Ligerimys florancei* and *L. ellipticus*, indicates that these fossil assemblages can be correlated with the Early Miocene (local zone Ca to Cb of the Early Aragonian, MN4). The presence of a new dimylid species, *Plesiodymylus ilercavonicus*, previously described only in Mas d'Antolino B-5, has now spread its stratigraphical range to the localities Barranc de Campisano-1 and Mas d'Antolino B-11. This is an intermediate to large-sized species with rather stout and amblyodont teeth within the genus and exhibits some primitive characters. This is the first record of this genus from the Lower Miocene of the Iberian Peninsula. The isolation of this population in a marginal area probably enhanced the speciation processes and the development of differential traits with respect to the Central European dwellers. The amblyodont teeth indicate that this species is one of the most malacophagous within the genus.

ID 278

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Two New Species of Bat in the Latest Miocene of Venta del Moro (Cabriel Basin, East of Spain)

Poster Presentation

The classical locality of Venta del Moro is situated in the Cabriel Basin (Province of Valencia, Eastern Iberian Peninsula). This site contains an abundant and diversified fauna and flora, comprising more than one hundred taxa. The mammal assemblage suggests a Late Turolian or Ventian age (latest Miocene, MN13, 6.23 Ma by palaeomagnetic dating). The presence of bat fossils in localities of fluvio-lacustrine origin is quite uncommon. This site has yielded remains of five chiropteran taxa, also these new species; we found the oldest and southernmost record of *Myotis podlesicensis*, *Nyctalus* sp. and *Vespertilionidae* indet. Two new bat species are described in the bat association of this site: the pipistrelle bat *Pipistrellus rouresi* and the horseshoe bat *Rhinolophus antonioi*. The first species is a new form to the extremely scarce Neogene register of pipistrelle bats. It would be a primitive representative similar to the species *Pipistrellus*-like group by the presence of well-developed paraloph and metaloph, with reduced metaconule and paraconule. Furthermore, the second species is characterized by its medium size with wide upper molars, belongs to the *R. mehelyi-euryale* group, and the posterior cingulum of the M3 connected to the distal cingulum of the metaflex, surrounding the metacone.

ID 265

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Completing the Picture – Spatio-Temporal Patterns of Multituberculate Distribution in the Uppermost Cretaceous of Transylvania, Romania

Oral Presentation

The latest Cretaceous vertebrate fauna of the Transylvanian Landmass (often dubbed the 'Hațeg Island'), in eastern Europe, is remarkable in many respects – it comprises presumably dwarfed herbivorous dinosaurs (*Zalmoxes*, *Magyarosaurus*, *Struthiosaurus*), aberrant carnivorous dinosaurs (*Balaur*), relict turtles (*Kallokibotion*) and crocodyliforms (*Theriosuchus*), and adaptively-radiated kogaionid multitu-

berculates, most of these vertebrates being also endemic to this region. Results of ongoing efforts to collect across the main outcropping areas with uppermost Cretaceous deposits are constantly updating our views concerning the distribution patterns of different vertebrate clades. In this regard multituberculates represent a prime example, where every new discovery can alter previously suggested patterns. Our international (Romania-USA-UK) collaborative team has succeeded in collecting a large number of multituberculate specimens during the last 5 years. While their study is still ongoing, preliminary results suggest that the interpretation of these specimens will change significantly our current views on the local diversity and spatio-temporal distribution patterns of this mammalian clade. The oldest known occurrence of Transylvanian kogaionids now extends into the Campanian, whereas the youngest Mesozoic record is probably late late Maastrichtian, accounting for a temporal range of about 4 to 5 my. In an island setting, characterized by accelerated rates of evolutionary change, such a temporal range would predict the presence of a higher diversity than that observed previously (only two genera with a total of three species), and our specimens indeed suggest the presence of new taxa, but also reconfirm that multituberculates were very common, the predominant group of mammals in the ecosystem.

ID 150

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Understanding the Axial Skeleton of *Concavenator*: Skeletal Adaptations for a Sacral Hump?

Oral Presentation

The carcharodontosaurian theropod *Concavenator corcovatus* is represented by a unique, almost complete and articulated skeleton from the Las Hoyas fossil site (Early Cretaceous, Spain). The axial skeleton lacks some caudal vertebrae but the rest is totally articulated. *Concavenator* shows several unusual features associated with the axial skeleton, such as some hypertrophied neurapophyses in the dorsal and caudal region. Here, we review the osteology of the axial skeleton of *Concavenator corcovatus* in order to assess these unusual structures. *Concavenator* shows several allosauroid synapomorphies in the axial region, such as: (1) constriction in the dorsal vertebral centrum; (2) expanded prezygocentrodiaepophyseal fossa in dorsal vertebrae; (3) broad and transversely-flattened distal end of chevrons; and (4) strongly curved 'L' shaped middle chevrons. Several autapomorphies are described: (1) two hypertrophied dorsal neurapophyses; (2) imbricated dorsal neurapophyses with anterior processes and variable morphology; (3) anterior and posterior accessory processes

in the anterior caudal neurapophyses; and (4) deeply excavated lateral groove in the posterior caudal vertebrae. Regarding the functionality, some of these autapomorphies are related to several novel mechanisms to stiffen the axial skeleton in order to counterbalance bending moments. This stiffening is usually related to a large-body size with the presence of specific high stress anatomical structures (eg. the tail club of ankylosaurs). In the case of *Concavenator*, it is proposed that this stiffening of its axial skeleton together with the enlargement of some neural spines could be related to the presence of a hump structure in the sacral region.

ID 217

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Finite Element and Shape Analyses Shed Light into Conodont Functional Morphology

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy
in Vertebrate Palaeontology

Conodonts are an enigmatic clade of early vertebrates whose mineralized skeleton is characterized by a series of tooth-like elements. A recent study applying Finite Element Analysis (FEA), occlusion and microwear analyses to the P1 elements of the genus *Polygnathus* (Devonian to Lower Carboniferous) has suggested that there is a biomechanical improvement associated with the evolution of wider platforms. Here, we analyze the specific shape changes that are associated with the aforementioned improvements in biomechanical capabilities in the genus. We combined geometric morphometric analysis with previous FEA results, taking phylogeny into account. We defined landmarks on 214 P1 conodonts in occlusal view from 18 *Polygnathus* species, comprising its first 15 Myr of evolution. After Generalized Procrustes Superimposition, we conducted PCAs on the shape data and combined the results with the outcomes from FEA. Our data have a clear phylogenetic signal, concordant with the fact that phylogeny in this group is drawn from morphological characters of the conodont elements. We recovered a clear evolutionary trend from older to younger species, consisting in the acquisition of proportionally wider and broader platforms in younger species. This trend is accompanied by conodonts with less

stress when subjected to the same loadings, confirming a biomechanical improvement associated with the development of enlarged platforms. This morpho-functional trend is suggestive of a dietary or foraging shift occurring during the evolution of *Polygnathus*.

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ID 223

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New Titanosaurian (Sauropoda) Remains of *Atsinganosaurus* from the Late Cretaceous Site of Velaux-La Bastide Neuve (Southern France)

Oral Presentation

The Late Cretaceous of southwestern Europe (the Ibero-Armorican Island) is full of fossil sites with titanosaurian remains, especially the Centre-North of the Iberian Peninsula and southeastern France. The titanosaurian diversity is updated to at least four taxa: *Lirainosaurus* and *Lohuecotitan* from Spain, *Ampelosaurus* and *Atsinganosaurus* from France; in addition, several morphotypes from both countries are currently under study and may represent new taxa. New titanosaurian material has been recovered from the French upper Campanian fossil-site of Velaux-La Bastide Neuve, where *Atsinganosaurus velauciensis* was found. This new material consists of several cranial (a partial braincase, an occipital condyle, a pterygoid, and four complete teeth) and postcranial remains (cervical, dorsal and caudal vertebrae, one sacrum with associated ilia, humeri, ulnae, metacarpals, two ilia and two ischia). It shares with the previously-described remains several features, but also adds new autapomorphies to the diagnosis of *Atsinganosaurus*, principally focused on the cervical vertebrae and ilia. The scoring for *Atsinganosaurus* has been updated, and the phylogenetic position of this French titanosaur has been reassessed, together with its relationships with the rest of the Iberoarmorian taxa. All three French taxa (*Atsinganosaurus*,

Ampelosaurus, and the Albian taxon *Normanniasaurus*) appear as basal lithostrotians and closely related, however their relationships with the Iberian titanosaurs are not well resolved. The Iberoarmorian titanosaurian faunas are important for the comprehension of the palaeobiogeography of the Late Cretaceous of this European area, and these new remains from Velaux-La Bastide Neuve clearly help to improve our knowledge of these sauropod dinosaurs.

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The Metatarsus of a Late Cretaceous Titanosaur (Dinosauria: Sauropoda) from the Kharga Oasis Of Egypt

Oral Presentation

Metatarsals of titanosaurian sauropod dinosaurs are rarely found, hindering understanding of their functional morphology and phylogenetic utility. Only a few titanosaurian taxa preserve a complete or even nearly complete metatarsus (e.g., *Bonitasaura*, *Epachthosaurus*, *Notocolossus*, *Opisthocoelicaudia*, *Rapetosaurus*). Here we reassess the metatarsus of a partial titanosaurian individual from the Upper Cretaceous (Campanian) Quseir Formation of the Kharga Oasis, Egypt, which was previously described in an unpublished thesis in 1999. As indicated in that work, metatarsals I, II, and V are definitively represented. Furthermore, one or both of the bones originally identified as metacarpals II and III may instead represent metatarsals III and IV, respectively; these are currently undergoing further study and comparisons to conclusively establish their identities. As such, at least most of the metatarsus of the specimen appears to be preserved. The metatarsals of many titanosaurs (e.g., *Epachthosaurus*, *Notocolossus*, *Opisthocoelicaudia*) are short and robust. In the Kharga titanosaur, however, the metatarsals are remarkably slender, in accordance with the gracile proportions of the remaining appendicular elements. Slender metatarsals also occur in other Afro-Malagasy titanosaurs, such as *Malawisaurus*, a new Tanzanian taxon, and *Rapetosaurus*. The putative metatarsal III of the Kharga titanosaur is also similar to that of *Lirainosaurus* from the Late Cretaceous Laño Quarry of Spain in its elongate proportions and its retention of prominent distal condyles. Gracile titanosaurian metatarsals have also been recovered from another Spanish Late Cretaceous site known as Chera. Ongoing work will elucidate the phy-

logenetic and paleobiogeographic affinities of the Kharga form and other slender-footed titanosaurian taxa.

ID 222

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Three-Dimensional Musculoskeletal Model of the Tail of the Titanosauriform (Sauropoda, Dinosauria) *Giraffatitan*: Analysis of Tail Muscle Moment Arms

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy
in Vertebrate Palaeontology

Analyses of muscle moment arms using 3D musculoskeletal computer models have been developed in fore and hindlimbs of several basal (*Lesothosaurus*) and more derived (e.g. *Argentinosaurus* and *Tyrannosaurus*) dinosaurs. Muscle moment arms are major determinants of skeletal muscle functions, and these analyses are of great value for assessing locomotion in extinct animals. However, no detailed analyses have yet been done to study the musculoskeletal system of dinosaur tails, perhaps because of the complexity of the tail muscles (e.g. presence of numerous insertions for one muscle). We have created a 3D musculoskeletal model of the tail of the titanosauriform sauropod *Giraffatitan* by digitizing all the caudal vertebrae and haemapophyses with photogrammetry and the software 'Agisoft Photoscan Professional' and then creating a model with the Computer Aided Design software 'McNeel Associates Rhinoceros 5.0. NURBS Modeling'. With this 3D model, we want to assess the methodology used for the analysis of fore and hindlimb muscle moment arms for the analysis of the muscles of the tail. We have created musculo-tendon units for each muscle, using the musculature of crocodilian tails as a model ('Extant Phylogenetic Bracket'). Each unit has been segmented, simplifying the analysis by 2 caudal vertebrae. The analyses of the muscle moment arms have been developed with the Computer Aided Engineering software 'GaitSym 3.0'. These results will be an important basis for future musculoskeletal and biomechanical comparisons.

ID 275

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New Record of Pachyostotic Snake from Bileća (Bosnia-Herzegovina) - What Does it Tell us

Poster Presentation, Student Contribution

The first records of Cretaceous marine snakes from Bosnia and Herzegovina date from the beginning of the 20th century. Two species, *Pachyophis woodwardi*, Nopsca, 1923, and *Mesophis nopcsai*, Bolkay, 1925, come from the same locality of Selišta, north of Bileća. A new record of pachyostotic snake originates from a new locality which is situated three kilometers northwest of Bileća. The preserved specimen consists of an articulated vertebral segment in laminated limestone. On this specimen, for the first time, we can study the morphology of three-dimensional vertebrae of Cretaceous snakes from Bosnia-Herzegovina. Twenty seven vertebrae and two imprints were preserved. Seven of them are detached from the slab. The anterior part of the string (first 20 vertebrae) is mostly exposed with its left lateral side. The last seven vertebrae can be observed in dorsal view on the slab. The two best-preserved vertebrae are almost square-shaped, resembling *Simoliophis rochebrune*, but are considerably smaller. Vertebrae and ribs are extremely pachyostotic, as is the case in *Pachyophis woodwardi*. Two questions now arise: whether the morphological similarity of vertebrae is sufficient for identification of the specimen as *Simoliophis rochebrune*, regardless of the size difference or, is the high degree of pachyostosis, in relation to the small-sized body, sufficient to maintain the species status of *Pachyophis woodwardi*.

ID 254

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To Put a Face to a Name: An Investigation of the Nopcsa Collection

Oral Presentation

Camptosaurus inkeyi was the second new dinosaur taxon named and very briefly described from Transylvania by Franz Baron Nopcsa, in 1899/1900. The material was never figured, nor were any accession numbers provided for it, and so the name has since been regarded a *nomen dubium*. In 1904, Nopcsa redescribed the element he referred to *C. inkeyi*, having misidentified the maxilla of what is now *Zalmoxes robustus* for a camptosaur dentary. This redescription, as well as a review of the catalogues at the Natural History Museum (London) and Nopcsa's further literature, has enabled indisputable identification of this specimen as

NHMUK R. 3401. This specimen was assigned in 1904 by Nopcsa to his '*Mochlodon suessi* Individual B', which he considered to consist of further disarticulated skull elements which have now also been identified. Indeed, the records indicate that many elements considered entirely separately by modern authors were attributed to one of thirteen individuals identified by Nopcsa, which we have been able to match with accession numbers by cross referencing the literature and the catalogues. Most importantly, this includes the lectotype of *Zalmoxes robustus* (NHMUK R.3392), which currently consists of a single dentary, but could potentially comprise much more of the skeleton. This opens a line of investigation, through modern anatomical knowledge of the fauna involved, and statistical analysis, to unravel the discrepancies in the available records to review the entire collection in terms of association, even in the absence of Nopcsa's field notebooks or detailed quarry maps.

ID 287

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Palaeoenvironmental Conditions of the Middle Triassic Vossenveld Formation in Winterswijk (the Netherlands) Revealed Through Geochemical Analysis

Oral Presentation

The Winterswijkse Steengroeve quarry complex in the east of the Netherlands exposes circa 40 meters of intertidal to shallow marine deposits of the Vossenveld Formation. This overall transgressive Middle Anisian sequence records a fluctuating sea level and comprises red marls, dark clays, calcitic microbial mudstones and well-defined dolomitic intervals. Microbial laminates preserve reptilian trackways whereas numerous beds within the succession preserve a shallow marine paleofauna through a relative abundance of skeletal material from sauropterygians, fishes, and crustaceans. We present a detailed lithostratigraphy accompanied by thermogravimetric, natural gamma-ray, magnetic susceptibility, stable carbon and oxygen isotope data that characterise the bulk sediment according to distinct facies. The red marls are likely subaerially-exposed carbonates, as indicated by a high terrigenous concentration combined with a high dolomite-calcite ratio. Stable isotope ratios of the dolomitic intervals reflect marine conditions, indicating substantial evaporation, which is in line with the shallow

enclosed character and close proximity to the equator of the deposition of the Winterswijk strata, similar to the present-day Persian Gulf. Increasing salinity along the section likely corresponds to a larger, basin-wide trend. Such palaeoenvironmental information aids understanding of this unique shallow marine palaeohabitat. Calcitic stable isotope ratios exhibit meteoric diagenesis, which is relevant to ongoing stable isotope analysis of osseous material. We furthermore present a preliminary correlation, supported by e.g. isotope signatures, with other localities within the Germanic Basin that will permit comparison of contemporaneous palaeohabitats and illuminate the pacing of sauropterygian diversification during the biotic recovery following the end-Permian mass extinction.

ID 123

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Results of a Scientific Excavation in the Clay Pit 'Unterfeld' (Early Oligocene) at Rauenberg (Germany) - New Taphonomical & Palaeoecological Data

Oral Presentation

Sediments assigned to the Lower Oligocene Fish Shale are exposed at the clay pit 'Unterfeld' near the city of Rauenberg, SW Germany, and are well-known for a wide range of plant, invertebrate and vertebrate fossils of excellent preservation. The site meets all requirements of a Konservatortlagerstätte. A project, financed by the Klaus Tschira Foundation GmbH, was initiated by us in 2014 to conduct a scientific excavation and to compile all available information on the site and its fossil content with the aim of evaluating the palaeoenvironment. During this project we registered and investigated > 40,000 fossil specimens, acquired by us during both collection and excavation work. Here, we present an overview of the abundance and diversity as well as the preservational conditions of fishes and tetrapods. In addition, we provide results of the excavation campaigns, in terms of quantity and quality of the fossils collected in the field, as compared with the collection material. With this data in hand, we reconstruct aspects of the depositional environment of the Fish Shale sediments. According to our data, the emplacement area of the Early Oligocene 'Rauenberg Bay' was affected by sea level changes and varying terrestrial input, that strongly influenced the life and death of the aquatic inhabitants of the bay. In addition, our results also imply an identification of the clay pit 'Unterfeld' as a Konservatortlagerstätte.

ID 237

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Macroevolution of Late Palaeozoic-Early Mesozoic Amniotes

Oral Presentation

The replacement of the therapsid/parareptile-dominated terrestrial faunas by archosauromorph-dominated ones during the Permo-Triassic was one of the greatest turnovers in vertebrate history. The three amniote clades were characterized by a substantial variety in body size. The devastation of the Permo-Triassic mass extinction (PTME), but then rapid adaptation of body size range and associated ecological niches during the Early to Middle Triassic recovery phase, could have been key factors to the success of Archosauromorpha. We present the first comprehensive study of body size evolution in Permo-Triassic amniotes, using phylogenetic comparative methods to assess variation in the evolutionary rates of parareptiles, archosauromorphs and therapsids. Heterogeneous rate models are recovered for both Parareptilia and Therapsida. The earliest parareptiles were characterized by low evolutionary rates, rates accelerated through their history, and reached a peak at the Permo-Triassic boundary during the diversification of Procolophonidae. Rates remained high throughout the Triassic. Evolutionary rates of the oldest Therapsida were close to normal background, but there was a substantial rate increase during the late Permian, and rates peaked before the PTME. Evolutionary rates of Middle to Late Permian dicynodontians were much higher than those of contemporary therapsids. Rates declined slightly after the PTME but stayed higher than during the early Permian. Evolutionary rates of archosauromorphs were homogeneous, implying that the increased evolutionary rates of Therapsida and Parareptilia did not confer an evolutionary advantage over Archosauromorpha. High evolutionary rates appear to be associated with short diversification pulses, but do not seem to guarantee the long-term success of a clade.

ID 210

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Geometric Morphometric Approaches to Infer Bite Force and Diet in Extinct Strepsirrhines

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy in Vertebrate Palaeontology

The cranial system in mammals is highly constrained. Feeding forces, phylogeny, and the need to protect the brain and sensory organs are all important factors driving the evolution of the shape of the skull. Here, we explore relationships between bite force, cranial, and mandibular shape to infer the dietary ecology and bite force in two extinct species of strepsirrhines. We collected data on molar and incisor bite forces using a bite force transducer on animals belonging to the Duke Lemur Center (All animal handling was performed according to protocol IACUC #A174-14-07, PI: A-C Fabre). We analyzed cranial and mandible shape using 3D geometric morphometric approaches for 18 species of strepsirrhines that differ in feeding ecology. In addition we use data on mandibular shape to infer the diet of extinct species of Archaeolemuridae and Adapidae and use the observed co-variation between bite force and mandible shape in extant taxa to infer bite forces in these taxa. Our results show that bite forces vary across species with dietary specialists differing in bite force, cranial shape, and mandibular shape. The covariation between bite force and mandibular shape was strong based on these data. Finally, mandibular shape data demonstrate that extinct species of Archeolemuridae and Adapidae were mostly folivores supporting the previous studies performed for these species.

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ID 174

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New Material of *Agerinia smithorum* (Primates, Adapiformes) from the Early Eocene Locality Casa Retjo-1 (NE Iberian Peninsula)

Poster Presentation

The recent description of two species of *Agerinia* from the Àger Basin (NE Spain), *A. marandati* from Masia de l'Hereuet and *A. smithorum* from Casa Retjo-1, has notably improved the previous knowledge about early Eocene Primates from the Iberian Peninsula. The last field campaign carried out

in Casa-Retjo-1 has provided additional material of *A. smithorum*, which was only known by a mandible bearing the p1 and p2 roots and all teeth from p3 to m3. The new sample consists of 13 isolated teeth and a fragmentary calcaneus. The morphology of the lower teeth is virtually identical to the holotype (double-rooted p2, similar degree of p4 molarization, well-developed m1 paraconid, small but distinct m2 paraconid). Regarding the upper teeth, the M2 of *A. smithorum* displays a small but distinct hypocone, well-developed paraconule, incipient metastyle and metaconule and very weak enamel wrinkling. These traits support the distinction between *A. smithorum* and *A. marandati* that shows better-developed hypocone, styles, conules and enamel wrinkling. Concerning the calcaneus, it presents features similar to notharctines and asiadapines, suggesting moderately active arboreal quadrupedalism as the mode of locomotion for this species. The progressive p4 molarization, the reduction of the paraconid in the lower molars or the enlargement of the hypocone in the upper molars from *A. smithorum* to *A. marandati* and, finally, to *A. roselli* reinforces the hypothesis of a single lineage integrated by these three species.

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ID 140

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The Jaw Adductor Musculature and Trochlear Mechanism in Stem-Turtles

Oral Presentation

The origin of turtles is a major question in amniote evolution. Since the skull has been considered one of the most important regions for determining amniote relationships, the turtle skull is a key feature in exploring their origin. In extant turtles, one major modification compared to other amniotes is the trochlear mechanism, in which the external jaw adductor musculature is redirected around the enlarged otic capsule. For that, a sesamoid cartilage within the jaw muscle tendon articulates with a bone projection. In Cryptodira, this develops on the dorsal surface of the otic capsule, but it develops on a dorsolateral expansion of the pterygoid in Pleudodira. Based on their otic capsule projection, several extinct taxa were considered closer to cryptodires, but

recent analyses suggested that some of them are part of the stem-lineage to Testudines. Hence, a cryptodiran-like trochlear mechanism likely originated earlier than the rise of the crown-clade. We made 3D reconstructions of the jaw musculature of *Proganochelys quenstedti* confirming that there was no need for a trochlea in this taxon since the otic chamber was not in the way of the musculature. We hypothesize that the progressive strengthening of the skull in turtle evolution is also largely related to the trochlear mechanism, due to its concomitant phylogenetic origin.

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A New Way to Retract the Turtle Head? Neck Morphology and Mobility in *Araripemys barreto*

Poster Presentation

Araripemys barreto is one of the best-known Brazilian pleurodiran fossils, with around 100 specimens across several collections worldwide. It is found in the Albian Romualdo and Aptian Crato formations of the Araripe Basin. Its bizarre morphology, resembling in numerous aspects that of trionychids, is well known from previous work; however, its neck morphology has not been discussed in terms of its mobility so far. We describe the neck of two new almost complete and articulated specimens from the Crato Formation and discuss potential neck movements. The cervical vertebrae (CV) 2-8 have nearly the same morphology with subtle variations in size along the series. The centra are slender and long, with large transverse processes projecting laterally. The articular surfaces of the prezygapophyses face dorsally. The postzygapophyses are fused in a crescent-shaped articulation. There is no evidence of disarticulation in the specimens and, thus, we measured angles between the cervical vertebrae as their potential minimal lateral movement. Angles above 50° were measured in all visible vertebral articulations, the highest being between CV4-CV5 (87°) and CV5-CV6 (106°). Greater mobility along the entire neck would have made possible a greater lateral mobility enabling neck retraction in a distinct way when compared to other pleurodires and cryptodires. This would be advantageous for *A. barreto*, since the carapace is not anteriorly-

expanded as in other long-necked pleurodires, but instead, has an anterior notch on the nuchal, restricting the dorsal protection to the neck. Ongoing research will model its potential movements to test this hypothesis.

ID 219

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3D Computational Biomechanics Meets Amphibians: Ecomorphology and Evolutionary Implications

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy in Vertebrate Palaeontology

Computational biomechanics offers a new opportunity to test paleoecological and evolutionary hypotheses in fossil and extant taxa. The ecomorphology of early tetrapods as well as living and fossil lissamphibians can be analyzed. Different feeding strategies appeared in amphibians and their functional implications have been discussed using neo- and paleontological data, providing clues about evolutionary history, particularly in urodeles. 3D cranial Finite Element (FEA) models of extinct Mesozoic early tetrapods (stereospondyl temnospondyls) and living urodeles (cryptobranchoids and dicamptodontids) under different biomechanical scenarios suggest various patterns in amphibians in general and urodeles in particular. In the last years, a theoretical framework was proposed to compare different FEA models using statistics, in order to quantify various patterns of stress. Latest results show that stereospondyls had peculiar paleoecological niches clearly differentiated from living giant salamanders, thus questioning ecological analogies with extant forms. On the other hand, cryptobranchoids, and particularly hynobiids, are excellent models for biomechanical reconstructions of early urodeles. Hynobiids present cranial biomechanical similarities with dicamptodontids, suggest-

ing that convergent characters, rather than phylogenetic ones, are key to the adaptation of the different crown-group salamanders to their environments. These results confirm the hypothesis of a cranial simplification during amphibian evolution. This simplification is probably due to changes in ossification patterns such as bone loss or ossification retardation. It may favor cranial stress distribution and could therefore be retained preferentially by natural selection.

ID 261

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An Overview of the Postcranial Skeleton Adaptations in Basal Glires (Mammalia)

Oral Presentation

Glires originated in the earliest Paleogene, near the K/Pg boundary, most probably in Asia. The basalmost Glires include Paleocene Eurymylidae and Mimotonidae and are morphologically and phylogenetically near to lagomorphs of a modern aspect. Our study focuses on the tarsal bones of basal Glires and stem lagomorphs from Asia, in order to reconstruct their ancestral locomotory adaptations. The duplicidentate lineage (Lagomorpha + Mimotonidae) since its origins (*Mimotona*) displays adaptations in foot structure leading to stabilization of the tarsal joint. In particular, the calcaneofibular facet (which, however, may or may not be associated with the fusion of distal tibia and fibula) is convergent on ungulates, *Pseudictops* (Euarchonta), and elephant-shrews. Similar morphology is also displayed by *Rhombomylus*, an eurymylid, which implies that presence of the calcaneofibular facet may be ancestral for Glires. Interestingly, *Gomphos* and *Mimolagus* (large Eocene mimotonids) do not have the calcaneofibular facet and their tarsal joint resembles that of rodents. The shape of the calcaneofibular facet in Lagomorpha (12 genera in total) was analyzed with morphometric tools. It shows a uniform geometry, not very different from that of *Mimotona*. We propose that basal Glires (and, in consequence, Lagomorpha) were predominantly terrestrial mammals, which originated at least in the earliest Paleocene and further increased cursorial abilities, unlike more generalized rodents.

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Skeletal Remains of *Phoebodus politus* Newberry, 1889 (Chondrichthyes: Elasmobranchii) from a Famennian Konservatagerstätte in the Eastern Anti-Atlas (Morocco) and its Ecology

Oral Presentation

The Devonian chondrichthyan *Phoebodus* has long been known from isolated teeth recovered from a wide variety of fossil localities, ranging from the Middle Devonian to the Upper Mississippian. Here we provide a preliminary report of the first discovery of substantial, partly-articulated skeletal and dental remains of a phoebodont, *Phoebodus politus*, from Famennian outcrops of the eastern Anti-Atlas of Morocco. Initial comparisons support the hypothesized close relationship of phoebodonts with the Upper Mississippian chondrichthyan *Thrinacodus gracilis*. Both taxa exhibit an anguilliform body and elongate slender cranium. However, *P. politus* also exhibits dorsal fins with ctenacanth-like fin spines, echoing informal records of similar fin spine and tooth associations from the Famennian of Alaska. This Moroccan material represents an important addition to the limited data set of Devonian chondrichthyans. As such, these data will provide a valuable test of recent phylogenetic hypotheses and add to analyses of early gnathostome diversity and disparity before and after the end Devonian Hangenberg Event. Among living elasmobranchs, *Chlamydoselachus* uniquely displays a body shape, snout-form and tooth morphology resembling those of *P. politus*. Acknowledging that the structure and likely biomechanics of the axial skeletons and jaws of these widely-separated genera differ considerably, we nevertheless suggest that *Chlamydoselachus* provides the best available living model for understanding the ecomorphology of this remarkable, late Devonian comparator.

ID 194

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Global Distribution of Neogene Hedgehogs (Erinaceomorpha, Mammalia)

Poster Presentation

Hedgehogs are rather common elements of present-day terrestrial ecosystems in Africa, Asia and Europe. However, their evolutionary history is obscured by some critical taxonomic uncertainties. The oldest erinaceomorphs have been documented in the Paleocene. Nonetheless, it was in the Oligocene when the first forms resembling present-day hedgehogs emerged. During the Miocene, the fossil record has provided evidence of up to four different hedgehog-like subfamilies (i.e., not considering the galericines). The distribution they had together was wider than in the present day, covering not only all the Old-World, but also North America. The present work is a first glance at the origin, distribution and evolution of these subfamilies, including the extant Erinaceinae.

ID 205

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The Biogeographic Origins of European Paleogene Trionychians

Oral Presentation

EAVP Annual Meeting Grant award winner

Early Paleogene faunas from Europe consist of a mosaic of endemic forms and taxa with either Asian and North American affinities. This pattern resulted either through direct dispersal of species from Asia or indirect dispersal from North America to Europe via Greenland. Turtles of the clade Pan-Trionychia (i.e., pig-nosed turtles, Pan-Carettochelyidae, and soft-shelled turtles, Pan-Trionychidae) are abundant during the Paleogene of Europe, but their biogeographic origins remain obscure. No confirmed Mesozoic trionychians are known from Europe, with the exception of a single occurrence of a Late Cretaceous pan-trionychid from Sweden. Whereas pan-trionychids occur throughout Europe starting with the early Paleocene, the earliest verified occurrences of carettochelyids are from the early Eocene. The overall resemblance of the earliest European carettochelyid, *Allaeochelys delheidi*, with older congeners from the southern margin of Asia, along with only cursory evidence of that clade in North America, hint at a dispersal route from Asia to Europe. The case of the earliest European trionychids is more complex, as at least two morphotypes are present in the Paleogene. The larger one, *Axestemys vittata*, shows strong affinities with coeval North American forms. Taxonomic attribution of the smaller, indeterminate morphotype

to either plastronids, cyclanorhines or trionychines, however, is currently not possible. It is nevertheless clear that the trionychian fauna from the early Paleogene of Europe is the result of multiple dispersal events, both from Asia and North America, probably because these turtles were able to overcome small marine barriers.

ID 145

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A New Database Developed for Pleistocene Mammals: www.paleogeographic.com

Poster Presentation

Paleontological source management represents one of the major challenge for Millennial paleontologists. Today, research and study requires a huge amount of discoveries and references, and it is of crucial importance to obtain data, in order to create consistent sets for statistics, anatomical comparison and paleoenvironmental reconstructions.

In practice, most web databases collect data of invertebrate species, and vertebrate tetrapods up to the Neogene. Only a few of them record data about Pleistocene mammal fauna, PBDB and NOW being the best known ones, respectively developed by teams at the University of Wisconsin-Madison and the University of Helsinki. Even few databases represent data within a contextualized land map, and often coordinates of sites and fossils are not available for download.

With this contribution, a new web database is presented, specifically developed for Late Pleistocene mammals. This time range includes a changing world, where wild fauna progressively left the scene in favor of modern species and humans.

www.paleogeographic.com represents the last 125.000 years and more through geomaps, completely developed with Open Source software and tools. All data are available with references, details about fossils and measurements, to which paleontologists can have access, and are encouraged to contribute to the enrichment of the database.

ID 192

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The First Record of a Gobiid from Brackish Waters

Oral Presentation
European Fossil Fish Symposium

Gobiiforms (gobies) are a highly diverse clade within fishes with over 2200 extant species. They are very adaptive, can be found in all aquatic habitats and can show amphidromous lifestyles. Gobies are divided into two major clades, the six-branchiostegal-rayed gobiiforms (6brG) and the five-branchiostegal-rayed gobiiforms (5brG). The oldest representative of the 5brG is *Gobius jarousi* Prikryl & Reichenbacher, 2017 from Lower Miocene marine sediments of the Czech Republic. Since goby taxonomy relies heavily on soft tissue features it is difficult to find defining characters for different goby groups that can also be applied to fossils. Many fossil species have hence been assigned to the genus *Gobius sensu lato*. Therefore, a revision of those species can give new insights into the past diversity of the group. The gobiiform fossil record currently consists of 142 species, 94 based on otoliths. Sometimes the otoliths are preserved *in situ* and this makes those fossils even more valuable for taxonomic studies. Here we present such a rare case: new discoveries of skeletons of '*Gobius*' *francofurtanus* from the Upper Rhine Graben. With the combination of morphology, morphometry and otolith features it is possible to assign this species to the Gobiidae and even to a modern genus. *Caffrogobius francofurtanus* is now the oldest gobiid known from brackish water. *Caffrogobius* can be found today around the Atlantic and Indian Ocean coasts of South Africa and the Seychelles. The presence of this today-tropical genus fits well with other studies that support a middle Miocene Climatic Optimum.

ID 125

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Ecomorphological Characterization of Southwestern Europe Murines (Rodentia) from the Latest Middle Mio- cene to the Mio-Pliocene Boundary (MN 7/8 – MN13)

Poster Presentation

Rodents are an impressive group of mammals for (palaeo) environmental studies because their high species diversity is correlated with a high ecological disparity. There is a considerable amount of information compiled for extant rodent species. However, these studies usually lack morphological data on dentition, which has led to difficulty in directly using existing ecomorphological data of extant rodents for paleoecological reconstruction. In this study, we infer the environmental ranges of extinct murine rodents by extracting habitat information from extant relatives. We developed an Elliptic Fourier Analysis on the first upper molar outlines, and, afterwards, we ran a principal component analysis. Therefore, we linked morphologies of extant and extinct taxa based on a phenogram through a cluster analysis. This phenotypic 'bracketing' approach is particularly useful in the ecomorphological study of small mammals, which is mostly represented by isolated teeth. As a case study, we used murine genera, ranging from the Iberocccitanian latest middle Miocene to the Mio-Pliocene boundary. The resultant phenogram shows a predominance of ubiquitous genera among the Miocene taxa, and the presence of a few forest specialists, along with the absence of open environment specialists. This appears to be related to the absence of enduring grassland biomes in the Iberian Peninsula during the late Miocene. Our results showed high consistency with previous studies, suggesting that this phenotypic 'bracketing' approach is a very useful tool linking changes in morphologies of molar outlines with ecological preferences, particularly in the ecomorphological study of small mammals, which are mostly represented by isolated teeth.

ID 298

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Population Genomics of Cave Bears in Late Pleistocene Europe

Poster Presentation

Symposium: Recent Advances on the Palaeoecology,
Evolution and Extinction of the Cave Bear

Cave bears went extinct at the onset of the Last Glacial Maximum leaving behind a rich fossil record in caves from

Western Spain to North-Eastern Siberia. European cave bears are divided into two major mitochondrial clades, *U. ingressus* and *U. spelaeus* that interacted in different ways in different parts of Europe. In the Swabian Jura, these clades came into secondary contact and coexisted for about 4,000 years before first *U. spelaeus* and later on also *U. ingressus* haplotypes went extinct. In contrast, in the Austrian Alps, despite occupying nearby caves for over 15,000 years, no evidence for mitochondrial gene flow was found between *U. s. eremus* and the later arriving *U. ingressus*. Optimized DNA extraction and sequencing protocols, using NGS technology, now allow us to investigate the population history of these taxa using genome-wide nuclear DNA data. Our results show that in the Swabian Jura *U. spelaeus* and *U. ingressus* are nearly indistinguishable at the nuclear level and probably represent a single population. In the Austrian Alps, however, *U. s. eremus* appears to be distinct from *U. ingressus*. These two different scenarios are supported by morphological, isotopic and dental microwear evidence. By using nuclear genomic data, we intend to assess gene flow and admixture between large and small bodied cave bears that thrived in these regions during the Late Pleistocene.

ID 246

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A Multiproxy Approach to the Cave Bear's Hibernation: Reconstructing the Physiology and Behaviour of an Extinct Animal

Oral Presentation

Symposium: Recent Advances on the Palaeoecology,
Evolution and Extinction of the Cave Bear

Cave bears (*Ursus spelaeus* Rosenmüller) are almost ubiquitous in the Upper Pleistocene deposits of Europe, mainly due to the accumulation of their bone remains in the caves in which they used to hibernate, which are true konzentration-lagerstätten. The ursids metabolism changes radically during the hibernation, allowing individuals to remain for months without feeding or drinking, without defecating or urinating, and even developing and giving birth to their offspring. The duration of hibernation in current bears varies greatly, depending on the seasonal availability of food resources. The same must have occurred with the cave bear along the Upper Pleistocene, with its extreme climatic changes. In this paper we will review the physiology and behavior of the cave bear by comparing C and N stable isotopes in bone collagen of bears from sites in the Northwest of the Iberian Peninsula. The study includes both

males and females, adults and offspring, as well as other large contemporary mammals. In general, cave bears had a plant-based diet, but their isotopic signal varies in parallel with the climatic cooling toward the end of MIS 3 in a reverse manner to other large herbivores. Perinatal values reflect the mothers' values during hibernation, while juveniles show differences in maternal investment. In addition, we will see the relationship between the occupation of the caves by different mitochondrial DNA lineages and the occupation of the surrounding territory through the use of strontium isotopes. These studies based on isotopic biogeochemistry and paleogenetics offer unexpected data on the paleobiology of this extinct animal.

ID 182

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Morphology of the Mandibular Sutures in *Metoposaurus krasiejowensis* (Temnospondyli) From the Upper Triassic of Poland

Poster Presentation

Symposium: Ecomorphology and Functional Anatomy in Vertebrate Palaeontology

The morphology of the mandibular sutures of the Late Triassic temnospondyl *Metoposaurus krasiejowensis* has been examined in order to determine their role in mandibular biomechanics. To date, no histological study of mandibular sutures in extinct vertebrates has been published, it only being known for cranial sutures, and consequently mandibular suture interpretations are mainly based on comparisons with previous studies of cranial sutures and with 3D cranial finite element analysis of this taxon. Different mandibular suture types have been found: interdigitated, shallowly interdigitated, overlapping, tongue and groove and abutting. Each of these types is designed to counteract a specific load. Based on previous works, it is usually considered that the shallowly interdigitated, tongue and groove and abutting sutures are associated with tension strains, the interdigitated type with compression, whereas the overlapping type could absorb and counteract variable strains. The tension-resistant sutures occur primarily at the anterior part of the mandible, mainly on the dentary; overlapping sutures have been noted in medial parts of the mandible and compression-resistant sutures have been observed mainly in the posterior portions, i.e., angular and prearticular. In addition, Sharpey's fibres occur along the periphery of sutural edges. The variability

of suture types along the mandible suggests a complex loading two regimes, compression and tension, impacting the mandible. Tension-resistant sutures could have led to an increase of volume of the jaws during opening, whereas compression-resistant sutures may indicate adaptations to generate strong bite forces. This interpretation matches with the proposed 3D-finite element bilateral biting model of feeding for metoposaurids.

ID 207

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How To Produce High Quality Thin Sections of Fish Otoliths Without Costly Equipment

*Poster Presentation, Student Contribution
European Fossil Fish Symposium*

The preparation of thin sections is important for micro-morphological studies of hard parts. Thin sections should be of uniform and predetermined thickness, and in some cases they should also be extremely thin ($\leq 10 \mu\text{m}$). Consistency in the results is important, especially when scarce and irreplaceable material, such as fossils, is used. For these purposes, a variety of equipment is commercially available, but its acquisition can be costly. Grinding by hand is the frequently-used cheap alternative, but requires significant experience to produce sections of uniform thickness. Here we present an easy improvement of the 'grinding-by-hand' technique to obtain accurate thin sections of fossil fish otoliths, showing clear growth rings. The samples come from the middle Miocene of the Vienna Basin. According to the standard method, the samples were placed in LR White resin and mechanically ground or sawed by a microtome into thicker sections. Then a section should be mounted on a glass slide and ground with abrasive paper to the desired thickness by hand. This step was improved by gluing three cover slips in a row on the glass slide. The flanking cover slips were raised by inserting a layer of aluminum foil underneath. The sample was glued on top of the middle cover slip. By accounting also for the mean thickness of the glue, this approach allowed the specimen to be ground uniformly down to approximately $10 \mu\text{m}$ thickness. This technique is a cheap alternative to costly equipment to produce very thin sections of uniform and predetermined thickness.

ID 188

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Variation Between and Within Species – A Case Study of Gobiidae and Oxudercidae

*Oral Presentation, Student Contribution
European Fossil Fish Symposium*

Gobiidae and Oxudercidae (gobies) together represent one of the largest groups within the Teleostei. Determining their fossil species is important for research in both biology and paleontology. As soft tissue is not preserved in fossil gobies the question arises: how reliably can a goby species be distinguished, when solely morphometric and meristic characters are used? To answer this question we used three species of the Gobiidae and seven species of the Oxudercidae ($n \geq 6$ per species). Methods included 16 morphometric and 12 meristic characters based on X-rays from all individuals and statistical analysis (ANOVA, t-test, PCA). The data revealed that intraspecific variation varies strongly between the species. Despite this, all species can be distinguished from each other based on the combination of their morphometric and meristic characters. The meristic approach showed a better separation potential than the morphometric one. The three gobiid species could be separated by the number of rays in the second dorsal fin (ANOVA, $p \leq 0.05$). Among the seven oxudercid species, univariate analysis revealed good separation for only three of them. In the multivariate space of the meristic characters all oxudercid species could be separated, whereas the two species of *Gobius* showed a small overlap. Our results provide for the first time sound data that species identification in gobies solely based on hard parts is possible. Considering the great diversity of modern goby species, additional studies including further species and specimens would help to further strengthen the outcome of this study.

ID 308

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New Tragulid Remains from the Neogene Siwalik Group in Northern Pakistan

Poster Presentation, Student Contribution

The lithostratigraphic Siwalik Group consists of a sequence of ancient river deposits that accumulated throughout Miocene to Pliocene times on the Indian Subcontinent. These sediments are highly fossiliferous and have been a focus of paleontological research for more than 100 years, with mammals being the best studied vertebrates. Among them, tragulids are a very common component represented by the genera *Dorcatherium* and *Dorcabune* and several species. However, there is uncertainty on the status of some of the species, and indications of the existence of further, as yet undescribed, species. Here, we present a preliminary morphometric analysis of over 300 hitherto undescribed teeth from three different Siwalik formations of northern Pakistan (Chinji: 14.2–11.2 Ma, Nagri: 11.2–10.1 Ma; Dhok Pathan: 10.1–3.5 Ma) stored at the Bavarian State Collection of Palaeontology and Geology. Our results indicate the presence of the species *Dorcatherium majus*, *Dorcatherium minus*, *Dorcatherium nagrii*, and *Dorcabune anthracotherioides*. Among them, *D. nagrii* and *D. minus* are highly overlapping in size, a character previously used to separate them. In addition, we found evidence for another, not yet described, *Dorcatherium* species which is intermediate in size between the large *D. majus* and the medium-sized *D. minus* and will be discussed in the light of the known *Dorcatherium* diversity.

ID 262

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Systematic Relationships of Fossil and Extant Cervids (Ruminantia, Mammalia)

Oral Presentation, Student Contribution

Cervidae (deer) has been subject to numerous phylogenetic studies. For decades, palaeontologists and neontologists explored the systematic relationships of cervids separately, focusing on morphological or molecular data, respectively. Current systematics of extant cervids reached consensus in some areas; however, there are still many controversies at genus and species level. So far, it has never been attempted to extensively investigate the relationships between fossil and extant cervids. To achieve this, morphological primary data from fossil and extant specimens were collected, and molecular data of extant species were compiled from public databases. These data were analysed using different phylogenetic approaches with varying data and taxon sampling. The results showed similar topological placements of some fossils in every approach and different placements for others. Similar placements potentially indicate more likely hypotheses in contrast to taxa with differing placements. Most Miocene cervids share some plesiomorphic features; therefore, they are placed as closely related to each other. These early cervids were either in a stem position or closely related to extant Muntiacini. Pliocene and Pleistocene cervids have a higher proportion of apomorphic features and are more similar to extant cervids. Therefore, most of these taxa were placed in unresolved positions within crown cervids and likely represent ancestors of modern cervids. This work provided new interesting insights into the systematics and evolution of fossil and living cervids. The results demonstrate that all-encompassing approaches to reconstruct the evolutionary history of a taxon are important and should be pursued in the future.

ID 137

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Palaeoecological Inferences for the Early Middle Aragonian (middle Miocene) of the Madrid Basin (Central Spain) Based on New Rodent Remains

Poster Presentation

The paleontological works around the Manzanares River in the metropolitan area of Madrid have provided new small mammal fossil remains from five levels in two different locations (Puente de Praga and Madrid Río2). The rodent association is similar in the five sites, the presence of eight taxa being recognized: *Megacricetodon primi-*

tivus, *Megacricetodon vandermeuleni*, *Democricetodon moralesi*, *Democricetodon* sp., *Armantomys aragonensis*, *Microdyromys koenigswaldi*, *Pseudodryomys ibericus* and *Heteroxerus rubricati*. A correlation of the levels to the upper part of biozone Db is established, representing one of the lowest time intervals within the middle Aragonian of the basin. The rodent association recorded represents a low equitable community characterized by the predominance of *Megacricetodon* and a poorly-represented fauna of glirids and sciurids. The inferred species richness for this interval is among the highest recorded in assemblages from the middle Aragonian of Madrid. The relative abundance of genera with 'open country' habitat preferences in the Db localities studied does not reach 20% of the association, whilst it is above 40% in those from succeeding biozones Dc and Dd. This could indicate a more humid or closer environment during biozone Db than in biozones Dc and Dd. This inference is also supported by the presence of *Pseudodryomys* and *Megacricetodon vandermeuleni*, restricted to biozone Db in Madrid, which are interpreted to have open/woodland and woodland/forest habitat preferences, respectively. Furthermore, the low frequencies of the genus *Armantomys* (linked to open environments) recorded in the Db interval are remarkable, since it is a common taxon in the Madrid Basin.

ID 110

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Form, Function and Evolution: Inferences of Cranial Function Through Biomechanical Modeling

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy in Vertebrate Palaeontology

The vertebrate cranium has been the subject of many scientific studies. In trying to understand the bewildering diversity in cranial form, previous studies have attempted to infer the functional consequences of variation in cranial shape and size by means of biomechanical models. Here, I review these approaches, highlighting potential pitfalls and opportunities associated with these models. Essential in all types of modeling is validation of the model using *in vivo* data. However, once validated, models allow a relatively easy exploration of parameter space and the inference of function in extinct animals either by direct modeling or by quantitative inference based on form-function relationships established for closely-related extant taxa. Whereas many recent studies have attempted to establish rather complex models linking cranial form to function (e.g. finite element models), basic assumptions of these models are often ignored rendering the results thereof difficult to interpret in an ecological and selective context. Often simple models with well-defined assumptions can provide equally important

insights into the form-function relationships of the vertebrate cranium while requiring significantly less investment.

ID 301

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Hybridisation between Cave (*Ursus spelaeus*) and Brown (*Ursus arctos*) Bears: Goyet as a Case Study

Poster Presentation

*Symposium: Recent Advances on the Palaeoecology,
Evolution and Extinction of the Cave Bear*

Previous morphological analyses have shown that Pleistocene brown bears (*Ursus arctos*) sometimes show intermediate morphologies between modern brown bears and Pleistocene cave bears (*Ursus spelaeus* s.l.). This raises the question whether these intermediate bears might represent hybrid or admixed individuals. In order to thoroughly assess the possibility that the brown bears from Goyet might be admixed individuals or hybrids we employ various methodologies in a very interdisciplinary collaborative project, including morphological analyses based on three dimensional geometric morphometrics. At a later stage radiocarbon dating, genomic, and isotope analyses will also be performed. At the Royal Belgian Institute of Natural Sciences, we obtained surface models from CT scans of mandibles and skulls of brown bears from Goyet and other Belgian cave sites. Principal component analyses on the shape data indicate that some of the Goyet bears have typical brown bear morphologies, but some of these bears are morphologically very similar to cave bears. The latter might have been hybrids and this will be further assessed with genomic analyses. Furthermore, alternative hypotheses will be evaluated. It might be that the brown bears had differing morphologies, because they lived in different times under different circumstances, which will be assessed using radiocarbon dating. Consequently, they could have had differing diets, which will be assessed using isotope analyses.

ID 270

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Forty Years Later: The Life and Death of the Pleistocene Cave Bear (*Ursus spelaeus*), and the State-Of-The-Art of a Vanished Animal

Oral Presentation

*Symposium: Recent Advances on the Palaeoecology,
Evolution and Extinction of the Cave Bear*

Forty years after the publication of 'The cave bear story' by the vertebrate palaeontologist Björn Kurtén, several aspects concerning the palaeobiology of this Quaternary icon are still poorly understood. These aspects are mainly related to its ecology, as well as dietary behaviour, competition with humans, and hybridisation with coeval brown bears. This introduction to the symposium will provide a brief history of cave bear research and will introduce the attendees to all major discoveries on cave bear palaeobiology. Cave bear bones have been found throughout the centuries, but were generally attributed to dragons or other mythical creatures. In 1774 Johann Friederich Esper first described cave bear skeletons as belonging to bears, though the thought they were polar bears. Twenty years later, Johann Christian Rosenmüller gave the cave bear its binomial name *Ursus spelaeus*, thereby recognising it as a separate bear species. Then it remained largely silent on the topic for almost two centuries until Björn Kurtén wrote his famous book. Since then many important discoveries have been made, including the recognition of several species within in the cave bear group *Ursus spelaeus* s.l. based on mitochondrial DNA. Nevertheless, the scientific community remains divided on many aspects of cave bear biology. And so, this introduction to the symposium will end with some important open questions, some of which are currently being studied by the symposium participants.

ID 271

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Geometric Morphometric Analyses of the Cave Bear (*Ursus spelaeus*) Mandible: Implications for Feeding Behaviour

Oral Presentation

*Symposium: Recent Advances on the Palaeoecology,
Evolution and Extinction of the Cave Bear*

The diet of Pleistocene *Ursus spelaeus* has been debated extensively. Traditionally, *U. spelaeus* was thought to be herbivorous, but more recently studies have shown that it was potentially omnivorous or even carnivorous relying solely on meat or carrion. The eight extant species of Ursidae occupy various dietary niches, which are expected to be expressed in mandibular functional morphology. These species can be used to generate a dietary morphospace, in which the position of *U. spelaeus* can be determined and interpreted. Different methodologies, however, may result in different outcomes. Here we will compare two-dimensional (3D) and three-dimensional (2D) analyses with each other. Landmarks for digitisation of the mandible have been chosen to reflect mandibular functional morphology. Specimens of the family Ursidae were digitised with a microscribe G2 in 3D and from photographs in 2D. Then, generalised Procrustes superimposition was performed on the raw coordinates. Allometry may be removed by regressing the Procrustes coordinates onto the logarithm of centroid size pooled per species, which may further change the results. Subsequently, principal component analyses (PCA) were conducted on the regression residuals, as well as two-block partial least squares analyses (2B-PLS) and regression analyses. PCA is capable of differentiating between dietary niches in both 2D and 3D analyses, but the results differ in that the cave bear plots with the omnivores in the one and with the herbivores in the other analysis. This (apparent) discrepancy will be discussed in an evolutionary and functional framework.

ID 291

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Ecomorphology of the Cave Bear (*Ursus spelaeus*)

Oral Presentation

Symposium: Recent Advances on the Palaeoecology,
Evolution and Extinction of the Cave Bear

The ecomorphology of fossil cave bears (*Ursus spelaeus*) has not yet been studied extensively. Knowledge thereof is, however, crucial for understanding their demise towards the end of the Pleistocene. Adaptations to specific environments may have posed important limitations as climate changed. To test this, the mandibular and cranial morphology of cave bears was analysed using 3D geometric morphometrics and compared to that of extant Ursidae from various environments. Landmarks for 3D digitisation of the mandible and skull were chosen to reflect functional morphology and provide adequate coverage of elements of interest. Extant and extinct Pleistocene Ursidae were digitised with a Microscribe G2. Generalised Procrustes

superimposition was performed and allometry corrected for using pooled regression analysis. Two-block partial least squares analyses (2B-PLS) were performed with the Procrustes coordinates and the environmental factors in different blocks. The present analyses show that classic cave bears had a morphology associated with altitudes higher or comparable to those that the modern brown bear inhabits, and relatively little precipitation, less than in the habitats of the modern brown and polar bears. This is consistent with climatic reconstructions, making it unlikely that *U. spelaeus* was adapted to withstand high precipitation. Cave bears did not actually live at higher altitudes than modern brown bears, but the results reflect that climate was colder and drier in the Late Pleistocene, and that climatic conditions currently prevailing at high altitudes were then present at lower altitudes.

ID 269

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Finite Element Analyses on the Skull and Talon of Haast's Eagle (*Harpagornis moorei*)

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy
in Vertebrate Palaeontology

The extinct Haast's eagle (*Harpagornis moorei*) was 30-40% heavier than the largest extant eagle. There has been speculation about its evolutionary history and ecology, though relatively little is known about its feeding behaviour. This study aims at understanding the evolution and ecology of *Harpagornis* by combining Geometric Morphometrics and Finite Element Analysis (FEA) on three-dimensional models constructed from CT-data of skulls and talons of Accipitridae. *Harpagornis*' talon occupies a position in morphospace close to its closest living relative *Hieraaetus* (smallest extant eagle). FEA shows that the talon of *Harpagornis* undergoes similar stresses to that of other large hunting raptors. Modularity analysis reveals the presence of two independent modules (beak and neurocranium) in the skull. *Harpagornis*' beak showed closer morphological affinities to other eagles, whereas the neurocranial morphology of *Harpagornis* was more like a vulture. FEA on the skull indicates that *Harpagornis* shows affinities with

vultures, rather than eagles, particularly when simulating pull back and dorsoventral pull motions. Our results suggest *Harpagornis* was an active hunter. Neurocranial morphology, however, clearly indicates a feeding behaviour more similar to vultures, possibly because of the large size of its prey (e.g., giant Moa). *Harpagornis*' neurocranial adaptation probably allowed a stronger and faster pull back motion to quickly remove large chunks of meat from the prey, similarly to vultures. Moreover, our results document a rapid evolutionary change, which allowed *Harpagornis* to exploit large sized prey. *Harpagornis moorei* therefore represents an extreme example of how freedom from competition in island ecosystems can rapidly influence morphological adaptation.

ID 307

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Two New Early Sarmatian s.st. (Latest Middle Miocene) Rodent Faunas from the Carpathian Basin

Oral Presentation

The new early Sarmatian microvertebrate localities of Kozárd (North Hungary, Nógrád County) and Vârciorog (West Romania, Bihor County) are of primary importance for the understanding of faunal evolution, as well as the palaeoenvironmental and palaeoclimatic changes during the late middle Miocene in the Central Paratethys area. Both localities are rich in invertebrates allowing the correlation of these continental faunas to the *Elphidium reginum* foraminifera zone and the *Mohrensternia* mollusk zone respectively (Early Sarmatian s. str.; Serravalian). Furthermore, Kozárd is the type section of the Kozárd Formation lithostratigraphical unit. The Cricetodontini are the dominant elements in both rodent faunas. The specimens from Vârciorog are regarded here as new to science and assigned to '*Cricetodon*' n. sp. The species from Kozárd is a more evolved form which is very similar to '*C.*' *klariankae* known from Felsőtárkány-Felnémet 2/3 (North Hungary), and thus assigned herein to '*C.*' cf. *klariankae*. We conclude that these three taxa belong to the same evolutionary lineage. The composition of the Kozárd fauna points to a relatively arid climate. This conclusion is in accordance with the available geological and palynological data, and is supported also by the composition of the ectothermic vertebrates. The fauna of Vârciorog indicates a more humid environment, through various glires, two *Democricetodon* species and probably the presence of *Amphilagus*.

ID 146

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The Redescription of *Patagosaurus* and the Early Evolution of Eusauropods

Oral Presentation, Student Contribution

While the evolution and phylogenetic relationships of Triassic sauropodomorphs as well as Late Jurassic and Cretaceous neosauropods have been well-studied in recent years, the evolution and phylogenetic relationships of Early to Middle Jurassic sauropods has received little attention. In Argentina, the fossils of the Early to Middle Jurassic non-neosauropodan sauropod *Patagosaurus fariasi* form one of the best preserved sauropod records from this period, outside of China. However, the taxon has not received critical osteological study since its first description in 1979, despite its presence in numerous sauropod phylogenies. After a thorough revision of all eight *Patagosaurus* individuals, several characteristics and autapomorphies were revealed, specifically on the axial skeleton. A new phylogenetic analysis retrieves *Patagosaurus* as sister-taxon to *Cetiosaurus*, more derived than *Shunosaurus* and *Tazoudasaurus*, and more basal to both turiasaurs and mamenchisaurs. The traditional cetiosaurid 'triad' of *Patagosaurus*, *Cetiosaurus* and *Barapasaurus* breaks apart in this analysis, as the last taxon is more basal than the first two. Moreover, a specimen previously assigned to *Patagosaurus*, which is now an unnamed new taxon, is recovered as a highly derived eusauropod, or even as a basal neosauropod. Finally, the Early to Middle Jurassic sauropod assemblage from Argentina, including *Volkheimeria*, *Amygdalodon* and unnamed taxa, shows a high phylogenetic diversity, including both basal and more derived specimens. This implies an earlier diversification of sauropods in the Jurassic than previously assumed, and the time window for this event is now pushed back further to at least the Early Jurassic.

ID 200

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Miocene Snakes from Northeastern Kazakhstan: New Data on the Evolution of Snake Assemblages in Siberia

Poster Presentation

The late middle Miocene vertebrate fauna from north-eastern Kazakhstan (Baikadam, Malyi Kalkaman 1 and 2; ~12.7-12.1 Ma) provided the best documented Miocene snake assemblage in central Asia. In total 10 taxa belonging to three families have been reported including: Boidae: *Albanerx* cf. *volynicus*, Boinae gen. et sp. indet.; Colubridae: *Coluber* cf. *hungaricus*, *Texasophis bohemiacus*, *Elaphe* aff. *dione*, cf. *Elaphe* sp., 'Colubrinae' A, 'Colubrinae' B; Viperidae: *Vipera* sp. ('European vipers' group, '*Vipera aspis*' complex) and *Gloydus* sp. The occurrences of *Albanerx* cf. *volynicus*, *Coluber* cf. *hungaricus* and *Texasophis bohemiacus*, which were probably widely distributed in Eurasia during the Miocene, support assumptions concerning possible faunal homogeneity in this region during the Miocene. Although it can be also supported by occurrences of *Vipera* 'Oriental vipers' and *Coluber* s.l., unnamed species A from the coeval east Siberian Togay site (Ol'khon Island, Baykal Lake, Russia), the presence of most probably extinct taxa which were unrelated to known European representatives ('Colubrinae' A and B from Baikadam and Malyi Kalkaman 2) as well as taxa which never occurred in central and western Europe and which are closely related to species recently inhabiting southern Siberia (*Elaphe* aff. *dione*, *Gloydus* sp. from Baikadam and Malyi Kalkaman 1) indicate, that faunal dissimilarity was relatively high within Eurasia during the late middle Miocene. This assumption is in accordance with research on European mammal assemblages which shows decreasing mammalian homogeneity during the MN 5 to MN 7+8 interval. The same model is probably applicable for the whole of Eurasia.

ID 206

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The Permian 'Microsaur' *Batropetes* as a Model for the Origin of Frogs

Oral Presentation
EAVP Annual Meeting Grant award winner

Micro-CT data from a postcranial skeleton of an adult *Batropetes palatinus* reveal a thin, solid cortex and extensive spongiosa in limbs, girdles and vertebrae, confirming previous interpretations of *Batropetes* as terrestrial. A mixture of adaptations to walking (short trunk, robust girdles and limbs) and digging (subterminal mouth) has led to the hypothesis that *Batropetes* searched for food in leaf litter and perhaps topsoil. We interpret *Batropetes* as having used its forelimbs for this purpose, using one forelimb to shove leaf litter aside: the forelimbs are unusually large compared to the hindlimbs, trunk and head; the first metacarpal and digit are robust; terminal phalanges are similar to claws. The latest publications on the Triassic stem-group frog *Triadobatrachus massinoti* concluded that early salientian evolution was not driven by specialization for efficient jumping. *Triadobatrachus* morphologically still lacked the ability to jump off, but had the forelimb strength necessary to withstand the impact of landing. We postulate that these forelimb features are exaptations from forelimb-based digging, for which *Batropetes* may represent an analog or possibly a homolog. Among frog relatives (lissamphibians), albanerpetids are considered head-based leaf litter diggers and caecilians are head-first burrowers; digging behavior is not ancestral for salamanders, but salamanders may be ancestrally neotenic. The closest relatives of *Batropetes* with a known postcranium were head-first burrowers. We evaluate the possibility of homology between any or all of these digging lifestyles, as well as those of head-first burrowing ostodolepidid, gymnarthrid and other elongate 'microsaurs', in an enlarged phylogenetic analysis of early tetrapods.

ID 214

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New Ornithopod Remains in the Bajo de la Carpa Formation (Santonian, Upper Cretaceous) from the La Escalada Area, Northern Patagonia, Argentina

Poster Presentation

Remains of ornithopod dinosaurs from the Upper Cretaceous of Argentina are abundant, allowing the description of several species. Over the last few years, the number of discoveries has increased significantly in the Rincón de los Sauces area (Neuquén province), where remains have

appeared in two different formations (Plottier and Bajo de la Carpa formations). In this work, we present three new postcranial bones of an indeterminate ornithopod from the La Escalonada site from Rincón de Los Sauces (Neuquén, Argentina). Those elements belong to the Bajo de la Carpa Formation (Santonian) of the Neuquén Group and constitutes the second record for this formation in Rincón de los Sauces. The recovered remains (MAU-Pv-LE-616 to 618) correspond to: a right pubis fragment, a dorsal vertebral centrum and a right ungual pedal phalanx. The dorsal vertebral centrum is eroded and the sutures with the neural arch (which is lost) are exposed. The pubis only retains part of the prepubic process and the iliac peduncle. The prepubic process is anteroposteriorly long, dorsoventrally narrow and the transverse section is triangular. The iliac peduncle is big and robust and is posteriorly directed. Its articular face is concave, quadrangular and is posteriorly directed. The right ungual pedal phalanx is of small size, slightly eroded, anteroposteriorly longer than lateromedially wide and its articular surface is elliptical. The new bones represent a diversity rise of ornithopods, in an area where there was no record of ornithopod remains until 2015.

ID 274

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Re-description of '*Steneosaurus*' *obtusidens* Andrews, 1909, an Unusual Macrocephalous Teleosaurid Crocodylomorph from the Middle Jurassic of England

Oral Presentation

Thalattosuchia was a unique group of marine crocodylomorphs that flourished during the Mesozoic Era, evolving a wide range of feeding specializations and environmental adaptations. One of the two major groups within Thalattosuchia is the teleosaurids, a semi-aquatic clade that ranged from the Early Jurassic to the Early Cretaceous (~182-132 million years ago). While their fossils have been known since the 18th Century, their morphological, alpha taxonomy and phylogenetic relationships are still largely uncertain. One current well-defined subclade within the teleosaurids is Machimosaurini. This group comprises *Machimosaurus* and '*Steneosaurus*' *obtusidens*. '*S.*' *obtusidens* represents a long known but poorly studied holotype from the Natural

History Museum (NHMUK) London. Here we re-describe the holotype of '*S.*' *obtusidens*, demonstrate that it is indeed a valid taxon, restrict the referred specimens to a fragmentary skeleton, nearly complete skull, and partial rostrum, and establish a new monotypic genus, *Lemmysuchus*.

ID 241

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Resolving Phytosauria: A Trifold Cladistic Approach

Poster Presentation

Historically the in-group phylogeny of Phytosauria has proven problematic, due to multiple 'wastebasket taxa', a limited set of characters, and poor transatlantic sampling. Recently, advances in parsimony analysis have permitted incorporation of alternative data types with the potential to help elucidate phytosaur phylogeny. Here we investigate the in-group relationships of Phytosauria and the impacts of discrete, continuous and geometric morphometric (GM) character coding methods on tree topology. Extensive first-hand study of European and American specimens, intensive investigations to identify novel characters, and uniting characters from previous analyses has generated the most taxonomically comprehensive cladistic dataset of phytosaurs to date, with an almost two-fold increase in phylogenetic information scored for each taxon. Alongside traditional phylogenetic methods, data are coded and analysed as non-discretised continuous ranges and landmark-based representations of shape using the software TNT, tackling issues of arbitrary or subjective character scoring. Continuous and GM character variants were systematically incorporated into a base discrete character matrix, resulting in four well resolved tree topologies, showing the effect of data type on phylogeny. The combination of all three coding techniques generated best tree resolution, despite continuous and GM scored characters containing more missing data than their discrete counterparts. Continuous and GM coding is limited due to higher dependence on complete, undistorted morphology, and GM especially as it is cumbersome to implement and greatly increases analysis time. Despite this our results support the trend towards using all available evidence in cladistics and highlights the importance of using appropriate scoring methods for individual characters.

ID 161

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The Early Miocene Rodent Succession of the Vallès-Penedès Basin (Catalonia, Spain): Preliminary Results after the 2011-2016 Field Campaigns

Poster Presentation

The Vallès-Penedès Basin is a classical area for the study of the Miocene terrestrial faunas of Europe. However, in comparison to the middle and late Miocene part of the record, the early Miocene has received less attention. Indeed, most of the currently-known sites were discovered more than 60 years ago and have not been systematically sampled since. Nevertheless, new major sites (such as els Casots) were discovered during the 1990s, and between 2011 and 2017 the early Miocene outcrops were systematically surveyed, resulting in the discovery of more localities. In addition, some of the classical sites were sampled using modern methods, including screen-washing, thus allowing for the recovery of remarkably rich samples of microvertebrates. For the time being, only a part of these samples has been studied, but preliminary data indicate that the early Miocene record of the Vallès-Penedès is more complete than initially thought. The oldest sites date back to the Ramlan (MN3) and are characterized by a diverse glirid fauna dominated by *Pseudodryomys ibericus*, *Simplomys simplicidens* and *Glirudinus modestus*. Cricetids other than the genus *Melissiodon* are absent. The early Aragonian (MN4) is better represented and characterized by the abundance of the cricetids *Democricetodon hispanicus* and *Megacricetodon primitivus*, as well as the eomyids *Ligerimys florancei* and *L. ellipticus*. Occasionally, the cricetid *Eumyarion* is present. The rodent succession is comparable to that of the well-known Calatayud-Montalbán Basin (Aragón, Spain), indicating that a similar biostratigraphical scheme could be applied to both areas. Ongoing magnetostratigraphical studies will provide valuable data for this purpose.

ID 283

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The First Record of the Etiini (Cichlidae: Pisces) from the Middle-Upper Miocene of Kenya

*Poster Presentation
European Fossil Fish Symposium*

Africa is home to a large diversity of one of the most diverse extant teleost families, the tropical freshwater Cichlidae. Nevertheless, cichlids have a very sparse fossil record rendering reconstruction of their evolutionary history difficult. In this study we present the first fossil record of the tribe Etiini, of which only one extant representative is known, *Etiá nguti* Schliewen & Stiassny, 2003. The fossils come from the middle-upper Miocene site Rebekka of the Ngorora Formation (10-12 Ma) in the Tugen Hills, Kenya. Six specimens, preserved in excellent condition, were studied. Their systematic interpretation is based on a large comparative dataset of X-rays of modern cichlids, encompassing representatives of all extant African tribes. The specimens resemble each other meristically (29-30 vertebrae, I/13 pectoral fin-rays, I/5 pelvic fin-rays, XIII-XIV/10-12 dorsal fin-rays, III/9-10 anal fin-rays). However, differences in their body shape indicate the presence of at least two species. They resemble the extant genus *Etiá* by having the combination of tricuspid teeth and two predorsal bones, but they differ from it in the morphology of the caudal fin skeleton, i.e. by having the third and fourth hypuralia fused, and a longer epural. For these reasons the specimens are tentatively placed in the tribe Etiini. They probably represent a new extinct genus. These new fossils are important not only because they shed light on the early evolutionary history of the enigmatic tribe Etiini, but also because they can serve as calibration points in order to more accurately date the phylogeny of cichlids.

ID 215

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From a Molecules' Perspective - Contributions of Ancient DNA Research to Understanding Cave Bear Biology

Oral Presentation

Symposium: Recent Advances on the Palaeoecology,
 Evolution and Extinction of the Cave Bear

Few members of the Pleistocene megafauna have been as extensively studied as cave bears. Multidisciplinary research into cave bears has provided insights into their morphology, ecology, and evolution. Genetic studies on cave bears have profited from the availability of large numbers of well-preserved remains. As a result, 'ancient DNA (aDNA)' from cave bears has provided significant insights into cave bear ecology, phylogeography and even potential causes of their extinction. I will review the contributions that genetic research has made to our understanding of cave bear biology and investigate the potential that new, genomic tools provide to shed further light on how these iconic representatives of the Pleistocene megafauna lived and died.

ID 300

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Blood Flow Index Indicates Elevated Metabolism in Synapsids Since the Bird-Mammal Split

Oral Presentation, Student Contribution

Varanids are the only reptiles that rival warm-blooded mammals for stamina. Conversely, much higher maximum metabolic rates (MMR) give endotherms (including birds) higher stamina than the ectothermic non-varanid reptiles. As low metabolic rates have been widely regarded as plesiomorphic to amniotes, the intermediate metabolism example of varanids has led to the hypothesis that mammalian endothermy evolved as a second step after the acquisition of elevated MMR in non-mammalian therapsids. Recent studies have found quantitative evidence for high metabolic rates only in neotherapsids but cannot distinguish varanid levels of MMR from that of non-varanid reptiles. Significant correlation with MMR in recent amniotes makes the index of blood flow into the femur (Qi) a proxy for MMR range in extinct animals. Here we show that Qi indicates elevated

MMR in synapsids even among the most basal-branching taxa. The non-therapsid synapsids and non-mammalian therapsids analysed, including caseids, edaphosaurids, sphenacodontids, dicynodonts, gorgonopsids and non-mammalian cynodonts, show Qi values in the range of recent endotherms, and varanids significantly distinct from other reptiles. Together with previous findings of high blood pressures in the basal synapsid *Dimetrodon grandis* our results strongly point to blood flow rates into the femur similar to that of recent endotherms. The results suggest that raised MMR either evolved in synapsids shortly after the bird-mammal split in the Mississippian or that the low MMR of ancestral lepidosaurs and turtles is apomorphic as has been postulated for crocodiles. Thus, stamina was likely raised in synapsids before the evolution of endothermy.

ID 156

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Brain and Labyrinth Anatomy of the Gondwanan Jurassic Sauropod *Dicraeosaurus*

Poster Presentation

Dicraeosauridae is a low diversity clade of diplodocoid sauropods with a spotty distribution but a significant time range (~28 Ma), suggesting an incomplete or deficiently sampled fossil record. Specimens of dicraeosaurids have indeed been extremely seldom found and, as a result, many aspects of their anatomy are currently poorly known. This situation is particularly unfortunate because dicraeosaurids are quite different from most other sauropod clades, being relatively short-necked, large-headed, and only moderate in body size. As expected, our ignorance is especially evident with respect to the neurocranium, which bears special importance for the information it conveys about the brain, inner ear, and other senses. In the light of CT-scan-acquired data and 3D renderings, we meticulously redescribe and extensively compare the brain neuroanatomy, inner ear morphology, and cerebral circulatory system of *Dicraeosaurus hansemanni*, the type species from the Late Jurassic of Tanzania. As in other sauropods, the endocast of *Dicraeosaurus* is remarkable for its huge pendant hypophysis (pituitary). Likewise, it is singled out for its dorsal excrescence—likely venous in origin—the voluminous development of which is not matched in any other sauropods. Huge olfactory bulbs, which are rarely found with a similar enlargement in other sauropods, project rostrally. The triangular semicircular canals of *Dicraeosaurus* are also at odds with those of other sauropods. All in all, the endocast configuration of

Dicraeosaurus is surprisingly different from not only other sauropods and diplodocoids, but also from *Amargasaurus*, a closely-related, although distant in time and space, dicraeosaurid taxon.

ID 266

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Freshwater Sharks from Krasiejów

Poster Presentation

The 'Trias' paleontological site in Krasiejów (Opole, Silesia, Southern Poland) is famous, first of all, for very rich accumulations of amphibian and reptile bones occurring in fine-grained terrestrial (alluvial) formations deposited during early Norian times (according to a new integrated revision of stratigraphy of the Upper Silesian Keuper). The ichthyofauna is also diversified here, however, lungfishes have not been described until now. Recently, we discovered Chondrichthyes, which belong to Hybodontiformes, a group that existed from the Devonian to Miocene and reached its maximum diversity during the Triassic. They are represented exclusively by isolated, small teeth (470 – 980 µm in length). The teeth are elongated in the anterior-posterior direction, relatively short and flattened laterally, with a poorly developed principal cusp at the crown, so the main crest is parabolic or undulating. At the lingual surface, there is a well developed, strong peg, just above the root attachment. The surface is smooth. All those general features are typical for the genus *Lonchidion*, which is quite common in the Mesozoic. Biometric analysis (consisting of differences in morphology and in proportions of size parameters) of about 500 teeth indicated 5 morphotypes, which most probably reflect various position of the teeth in jaws of specimens belonging to one species. The genus *Lonchidion* has been reported from the Upper Triassic of Poland for the first time, and taxonomic relations between the species from Krasiejów and other species known from Europe, USA or India are still unclear. Strontium isotope analysis confirmed a freshwater life habitat for the presented shark.

ID 273

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Lateral Manus Orientations in Sauropod Dinosaur Trackways: Implications for Sauropod Locomotion

Oral Presentation, Student Contribution

Sauropod trackways typically show anteriorly to antero-laterally oriented manus impressions, suggesting a high degree of manus pronation not seen in bipedal non-sauropod sauropodomorphs. Examples showing the plesiomorphic condition—a laterally facing, semi-supinated manus—are rare. The occurrence of both anteriorly and laterally facing manus prints within trackways indicates a great rotational degree of freedom in the sauropod forelimb. New data comes from the Middle Jurassic Tafaytour tracksite in the Western High Atlas of Morocco, which features at least ten trackways and numerous isolated prints preserved on a highly bioturbated surface, including some of the most narrow-gauged sauropod trackways known. Nine of the trackways feature lateral, in some cases even posterolateral, manus orientations, which average at 104° in relation to the direction of travel in the most extreme example. Statistical analysis was carried out on a large sample (n=72) of sauropod trackways from around the world, allowing for the following conclusions: first, high manus supination angles are restricted to smaller trackmakers (pes length < 60 cm). The absence of high supination angles in larger individuals can be explained by constraints imposed either by the increased body weight or by the increased joint ossification in older, and thus larger, individuals. Second, supination angles in smaller sauropods are negatively correlated with proxies for relative locomotion speed ($p < 0.001$). Thus, individuals tend to pronate their manus at faster speeds, facing it anteriorly and allowing it to contribute to the propulsion of the body, while retaining more lateral manus orientations at lower speeds.

ID 226

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Reassessment of a Partial Titanosaurian Sauropod Dinosaur Skeleton from the Upper Cretaceous (Campanian) Quseir Formation of the Kharga Oasis, Egypt

Poster Presentation

Dinosaur fossils are extraordinarily rare from the latest Cretaceous (Campanian–Maastrichtian) of continental Africa and Arabia (Afro-Arabia), with the majority of finds consisting of isolated, fragmentary teeth and bones. Due to this lack of informative material, the phylogenetic and paleobiogeographic affinities of Campanian–Maastrichtian Afro-Arabian dinosaurs have remained all but unknown. Here we reassess an associated partial postcranial skeleton of a titanosaurian sauropod dinosaur from the Upper Cretaceous (Campanian) Quseir Formation of the Kharga Oasis of the Egyptian Western Desert. The specimen was collected by researchers from the Technische Universität Berlin in the 1970s and was the subject of two abstracts and an unpublished thesis in the 1990s, but it has never been formally described. Consisting of five dorsal vertebrae and 12 appendicular elements (?coracoid, ulna, pubis, tibiae, fibula, metapodials), the skeleton constitutes one of the most complete dinosaur specimens yet recovered from the latest Cretaceous of Afro-Arabia. The dorsal vertebrae exhibit distinctive features: an anterior dorsal has an 'X-shaped' centroprezygapophyseal/intraprezygapophyseal lamina complex, and a posterior dorsal possesses a bifid 'accessory' lamina that arises from the anterior centrodiaepophyseal lamina. The proportions of the appendicular elements indicate an unusually slender-limbed animal, comparable in this regard to the penecontemporaneous Spanish lithostrotian *Lirainosaurus*. The Kharga specimen is also one of the few titanosaurs for which the metatarsus is well represented, thereby offering information on this inadequately-characterized anatomical region. Work currently underway will lead to the first formal description of the specimen, with the goal of clarifying its phylogenetic affinities and paleobiogeographic significance.

ID 112

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Looking Beyond the Fossils - Integration of Preserved and Theoretical Morphologies in Biomechanical Analysis

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy
in Vertebrate Palaeontology

New methods in digital visualisation, virtual reconstruction and computational biomechanical analysis have significantly transformed the way in which fossils have been studied in the past decade. Facilitated by the advent of new hard- and software tools, these techniques are now becoming routine techniques in vertebrate palaeontology. However, by their very nature vertebrate fossils are often incomplete, broken or distorted when they are found. Furthermore, the comparatively small sample size of most vertebrate taxa makes it difficult to account for effects of intraspecific variation, sexual dimorphism, ontogeny and allometry. This

presents a significant problem for the functional analysis of specific morphologies or anatomical structures and features and the respective comparability of biomechanical behaviour. The integration of theoretical morphologies provides a versatile solution to this problem. Using digital modelling techniques a wide range of theoretical morphologies can be created, which can subsequently be subjected to biomechanical analyses to test the functional significance of morphological features. This approach not only permits the overcoming of limitations posed by the incompleteness of the fossil record and preservation, but can also increase sample size significantly. Comparing theoretical models with actually preserved vertebrate morphologies allows ground-truthing this approach and testing hypotheses on morphospace occupation and convergence. Different case studies on the mandibular morphology of herbivorous dinosaurs will be presented and the advantages, disadvantages and possibilities of this approach will be discussed.

ID 295

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Tribal Warfare: Alien Facehuggers on Mesozoic Suspension-Feeding Fish

Oral Presentation

European Fossil Fish Symposium

Reduction in preservation potential for the axial skeleton means that, although known for well over a century, large pachycormids are primarily represented by incomplete, fragmentary, disarticulated and distorted remains. An exception is that the skull and pectoral girdle maintain a higher degree of ossification relative to the rest of the body. In a group with such reduced skeletal ossification, it is hard not to base phylogenetic assumptions on the limited skull material present. However, pachycormids show a remarkable conservatism in their dermatocranial anatomy, and while the few differences are useful for showing the separation of genera, they are of little utility in working out broader intrafamilial relationships. Although challenging to code compared with dermatocranial characteristics, the inclusion of several postcranial features in the pectoral and pelvic fins, supplemented by splanchnocranial characters from the gill basket, produces a much clearer picture questioning the traditional perception of a single carnivore lineage. *Protosphyraena* emerges as secondarily carnivorous from the suspension-feeding tribe of pachycormids (SFPs), reflecting 130 years of misidentification of North American *Bonnerichthys* specimens as *Protosphyraena*.

Unexpectedly, new data from the only virtually complete (including scales) specimen of *Protosphyraena* suggests that it possesses more characters in common with SFPs than with its 50 million year older Jurassic predator cousins *Orthocormus* and *Hypsocormus*, despite the superficially similar fanged or tusked appearance. Confirmation of this will rely on the further recovery of skull morphology data of SFPs. These new results on a well-established historical taxon reveals surprising complexities within this remarkable group of animals.

ID 111

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The Largest Example of *Ichthyosaurus*: A New Specimen of *Ichthyosaurus somersetensis* Containing an Embryo

Poster Presentation

An undescribed specimen of *Ichthyosaurus* from the collection of the Niedersächsisches Landesmuseum in Hannover, Germany, provides valuable new information. It was collected from the Lower Jurassic strata (Hettangian, Blue Lias Formation) of Donniford Bay, Somerset, UK and represents the largest known definite example of the genus. The skull, specifically the morphology of the maxilla, lacrimal, and jugal; the shape of the humerus, in particular its proximal region; the hindfin with one element in broad contact with the astragalus; and the morphology of the ilium that is more oblong than rib-like, justify a referral to *I. somersetensis*. Although being a composite (almost the entire tail has been added) the specimen provides new information on the morphology of the pelvis and hindfin of the species. The ilium is unusual in possessing a fork-like proximal end, which so far has not been described in any example of *Ichthyosaurus*. There are four elements in the third row of the hindfin, indicated by the presence of a bifurcation, which has not been reported in the species and has wider implications for the taxonomic utility of hindfins in the genus. Regardless of the incomplete preservation, the estimated total length of this individual, based on the skull and precaudal length, is between 310 and 340 cm. It is thus the largest known example of the genus *Ichthyosaurus*. Furthermore, an embryo is preserved with the specimen, which is only the third embryo known for *Ichthyosaurus* and the first to be positively identified to species.

ID 248

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Presence of *Karydomys* (Rodentia, Cricetidae) in the Miocene of Chios (Greece)

Poster Presentation

Karydomys is a rare cricetine rodent of which only five species are known currently. Its oldest record (*K. debruijnii*) comes from the Early Miocene (MN3) of northern Xinjian (China). By MN 4 (late Early Miocene), the genus had already achieved a wide geographical spread, being attested to in Kazakhstan (*K. dzerzhinskii*) and Greece (*K. boskosi* and *K. symeonidis*). *Karydomys* was present by early Middle Miocene time (MN5) in south-western and central Europe (*K. zapfei* and *K. wigharti*, respectively), where it became extinct shortly thereafter (MN6). Recent fieldwork in the Miocene of Chios Island (eastern Aegean Sea) resulted in the discovery of a diverse fauna of micromammals, including two second lower molars of *Karydomys*. These fossils come from a fossiliferous lens located at the base of the Kerameia Formation, within the brickyard quarry 'Michalos', close to the village of Thymiana (about 8 km from Chios town). The specimens differ from all known species of *Karydomys*, except for *K. symeonidis* from Karydia, with which they show strong morphological affinities. They can be distinguished from the other Greek species, *K. boskosi*, particularly with regard to the development of the mesolophid, which is longer in the specimens from Chios. The presence of *Karydomys* is of interest from a biostratigraphical point of view. The Kerameia Formation has usually been attributed to the Middle Miocene based on correlations of the mammalian assemblage and magnetostratigraphic investigations. The presence of *Karydomys* at the base of 'Michalos' suggests that the lowermost part of the Kerameia Formation is older than previously thought.

ID 252

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Methodological Problems in Cladistic Analyses of Fossil Actinopterygians

Oral Presentation
European Fossil Fish Symposium

More and more scientists realize that including fossil taxa in Total Evidence analyses is not only necessary to achieve a solid pattern of phylogenetic relationships, but also to fully understand macroevolutionary processes. Natural Selection acts on phenotypes and, thus, morphology, the only available information for fossils, should logically reflect phylogenetic signals. However, the treatment we have done to this imperative source of information has been faulty and is probably misleading. I will discuss two main flaws causing these problems: incomplete data sets and wrongly defined characters. The first of these faults is a consequence of the inclusion of only arbitrarily selected taxa and characters. The second fault is due to problems with character state identity of 'absent' states and the improper binary coding of multistate variation. To explain these faults, I will provide pedagogical hypothetical models and real examples taken from published literature. Many European fossil actinopterygian taxa are exceptionally well represented by unusually well-preserved and excellently prepared fossils offering an extraordinarily rich source of morphological information. Treating this information properly represents a powerful tool to elucidate the patterns and understand the processes that have been driving the evolution of modern European fish faunas.

ID 113

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A New Rodent Species from the Oligocene of the Valley of Lakes (Mongolia): Systematics and Palaeobiogeography

Oral Presentation

We describe a new species of Rodentia (Mammalia), *Argyromys cicigei* sp. nov. from Toglorhoi (fossil bed TGW-

A/2a) in Mongolia and Ulanatal (fossil beds UTL 1 and UTL 7) in China. *Argyromys aralensis* from Akespe (Kazakhstan) displays different size and more complicated structures. The presence of common characters indicates a closer relationship of *Argyromys* with the genera of Cricetidae s.l. (subfamilies Eucricetodontinae; Cricetopinae; Cricetodontinae and Gobicricetodontinae, among others) from Asia than with the earliest representatives of Spalacidae or the endemic Tachyoryctoididae, as was previously indicated. *Argyromys cicigei* sp. nov. possesses a simple anterocone and anteroconid in the upper and lower first molars, respectively, which is characteristic for Cricetidae s.l. It has a flat occlusal surface in worn specimens; weakly-developed posteroloph; an oblique protolophule and metaloph on the upper molars, and it lacks a labial anterolophid on the m1. These traits are also typical of the Oligocene genera *Aralocricetodon* and *Plesiodypus*, included in the subfamilies Cricetodontinae and Gobicricetodontinae respectively. A cladistic analysis places *Argyromys* as a member of Cricetidae s.l. The clade formed by *Argyromys* species is grouped with other cricetid taxa (s.l.). Spalacids, however, form a different clade, as do the tachyoryctoids. The present work supports the authors that date the Aral Formation (Kazakhstan) to the Oligocene instead of the Miocene, based on the presence of several taxa. The finds of *Argyromys* in Kazakhstan, China and Mongolia suggest the biogeographic unity of the Central Asian bioprovince during the Oligocene.

ID 234

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New Morphological Study on Gliridae Using Enamel Thickness and Enamel Dentine Junction

Poster Presentation, Student Contribution

Gliridae is a monophyletic group of rodent which is now widespread in Europe, Africa and Asia. The appearance of the earliest member can be traced back to *Eogiliravus* from the early Eocene Europe. However, the classification of fossil Gliridae is mainly based on the morphology of the cheek teeth with some distinctive so-called 'accessory' crests. Although the enamel thickness and the enamel dentine junction (EDJ) surface morphology have been proved to preserve important information in hominine systematics and dietary adaption, these features have still not been taken seriously into account in rodent systematic studies. We used micro-CT to compare the enamel thickness and the EDJ surface morphology among the first upper and lower molar of various fossil and extant glirid taxa. The result shows that the enamel thickness greatly differs between some distant relative species whereas it is more similar among taxa that are closely related. We also observed that the EDJ

morphological pattern is simpler than the occlusal surface. These new characters observed from 3D virtual images can provide new insight into the systematic classification of Gliridae and offer a great potential for understanding the changes of enamel development during their evolution.

ID 247

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First Occurrence of *Testudo kalksburgensis* Toulà, 1896 in the Czech Republic

Poster Presentation

Czujan's sand-pit locality (CSP) from the Middle Miocene (MN6-MN7+8, Mikulov, Czech Republic) is known for its singular mammalian assemblage, but reptiles have not received any attention, and more specifically, fossil turtles have never been studied in detail. We report unpublished material of the medium-sized tortoise *Testudo kalksburgensis* Toulà, 1896 (Testudines: Testudinidae) from Czujan's sand-pit (CSP), which is housed at the Moravian Museum in Brno, as well as presenting a revision of the type material from Wien-Kalksburg (MN5-MN6, Austria), housed at the paleontological collections of the University of Vienna. The new material from CSP is formed by several complete shells, multiple shell fragments and postcranial remains, which are assigned within the subgenus *Chersine*. Furthermore, the new material further allows us to ascertain the first record of *Testudo kalksburgensis* in the Czech Republic, and likely extends the chronostratigraphic range of this species to the late Serravallian (although the age of CSP is still contentious). All this material, together with the remains of the type locality (a partial shell), will enable in the future an emended diagnosis of *Testudo kalksburgensis*, which is characterized by a trapezoidal anterior plastral lobe. Our assessment further indicates that *Testudo kalksburgensis* is closely related to *Testudo catalaunica* Bataller, 1926 and *Testudo steinheimensis* Schleich, 1981. More detailed comparisons with other small-medium tortoise remains from Middle Miocene localities from West and East Europe would be required to evaluate the presence of *T. kalksburgensis* outside Central Europe, as well as to clarify the position within the subgenus *Chersine*.

ID 201

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Occurrence of *Diplocynodon ratelii* (Crocodylia) in the Czech Republic

Poster Presentation, Student Contributions

The Early Miocene deposits of the Bohemian area in the Czech Republic contain a lot of fragmentary remains of fossil crocodilians. Despite this wealth, the absence of complete and well-preserved cranial remains have meant that a confident taxonomical assessment of these findings, traditionally referred to the family Diplocynodontidae, has been elusive. Nonetheless, we report the first almost complete skull (UW6526A1-A4), osteoderms (UW6526A2,3) and isolated vertebra (UW6526A5) from Northwest Bohemia (Most Basin), housed at the paleontological collections of the University of Vienna. These specimens were recovered during the 19th century – but never described – from an unknown locality within the basin. They are attributed to the extinct alligatoroid genus *Diplocynodon*, which includes nowadays nine valid species from the Tertiary of Europe. Our comparisons were based on two alligatoroid taxa: the type species *Diplocynodon ratelii* from the MN2 of Saint-Gérand-le-Puy (France) and the recently described remains from the MN4 of Els Casots (Spain), as well as *Diplocynodon ungeri* from the MN5 of Schöneck (Austria). According to the cranial features, they are assigned to *Diplocynodon ratelii*, which is currently the only taxonomically valid species from the Early Miocene of Europe. Concerning the paleoecology, the occurrence of this crocodilian implies that permanent water masses were present, as well as a relatively high mean temperature. Furthermore, the studied remains represent the first report of *Diplocynodon ratelii* in the Czech Republic, and open the door to discuss the geographical and temporal distribution of this species in Central Europe.

ID 243

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Paleoherpetofauna from the Early Miocene Locality of Les Cases de la Valenciana (Catalonia, Spain)

Poster Presentation

The Miocene record of the Vallès-Penedès Basin (NE of the Iberian Peninsula) has provided a rich and diverse herpetofauna (amphibians and reptiles), which is known in the literature since the early 20th Century, thanks to the pioneering work of Bergounioux and, subsequently, Crusafont and Hoffstetter. However, the early Miocene localities have received little attention in comparison to the middle and late Miocene ones from the same basin, and furthermore no comprehensive study of the herpetofauna assemblages of any locality of this area has been conducted for more than fifty years. Here we report on the herpetofauna from the Early Miocene (MN4) site of les Cases de la Valenciana (Gelida, Alt Penedès), including the published remains discovered in the 1950s by Crusafont and the new findings recently recovered by the team of the ICP in the new excavation campaigns from 2012 until 2016. Two turtles, including a large tortoise *Titanochelon* cf. *bolivari* and a freshwater turtle *Ptychogaster* (*Ptychogaster*) cf. *emydoides*, a snake cf. *Python* sp., and an alligatoroid crocodylian *Diplocynodon* cf. *ratelii* are identified. The recorded herpetofauna suggests various ecological environments: arid landscapes with open woodland are inferred for the heliophile testudinid; a riparian forest for the semiaquatic ptychogasterine; as well as a small and shallow lake, indicated by the presence of the small alligatoroid. According to the rodent fauna, the age of the site is constrained between 16.3–16.0 Ma, thus it provides an excellent opportunity for the study of the composition of the fossil reptiles of the area during the Miocene Climatic Optimum (17–15 Ma).

ID 153

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The Dentition of *Mosasaurus lemonnieri* (Mosasauridae) from the Campanian and Maastrichtian of Belgium

Poster Presentation, Student Contribution

Mosasaurus lemonnieri is a mosasaurine mosasaurid originally described from the lower Maastrichtian (obtusa Zone) of the Ciply area, Mons Basin, southern Belgium. Despite being represented by numerous specimens, the knowledge of certain aspects of its anatomy is still incomplete. For example, the dentition of *M. lemonnieri* has been compared to that of other *Mosasaurus* taxa even though only a general description of the teeth of *M. lemonnieri* has been published. An assessment of the dentition of *M. lemonnieri*, based on observations and measurements of 359 teeth in 15 individuals (incl. holotype), from the upper Campanian to upper Maastrichtian strata of Belgium (3 individuals from Spiennes, 11 from Ciply-Malogne, and one from Saint-Symphorien), revealed morphological variability with possible taxonomic implications. In most individuals, the labial and lingual surfaces are fluted. However, as the size of the individuals increases, the labial surface becomes faceted. The carinae are unserrated in all but one of the studied specimens (contrary to what has been claimed). Finely serrated carinae were observed only in the individual from Saint-Symphorien (upper Maastrichtian) which might suggest a taxonomic distinction. As in *M. hoffmannii*, the distal carina is positioned labially in the anterior and middle parts of the jaws of *M. lemonnieri* but moves to a distal direction in posteriorly-situated teeth. Linear discriminant analysis (LDA), using morphometric data obtained from the tooth crowns of 6 taxa represented in the Upper Cretaceous of Belgium and the Netherlands, correctly classified ~80 % of the teeth of *M. lemonnieri*, suggesting their good distinguishability on a regional scale.

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ID 152

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Reappraisal of the 'Dorking Specimen': An Upper Cretaceous Brachauchenine Pliosaurid from England

Poster Presentation

Brachauchenine pliosaurids were marine macropredatory reptiles that might have been the only evolutionary lineage of pliosaurid plesiosaurs that crossed the Jurassic-Cretaceous boundary. Yet progress in understanding their origins and phylogenetic relationships has been hindered by limited knowledge of Early Cretaceous brachauchenine pliosaurid diversity and disparity relative to Late Cretaceous members of the clade. Late Cretaceous brachauchenines currently include only three valid taxa: *Brachauchenius lucasi* and *Megacephalosaurus eulerti*, initially described from the Turonian of Kansas, as well as '*Polyptychodon*' *hudsoni* from the Turonian of Texas. In Europe, the clade has long been represented by the widely distributed taxon *Polyptychodon interruptus*. However, recent reappraisal of the original type material of *Polyptychodon* from the mid-Cretaceous of England has shown that *P. interruptus* lacks diagnostic features, prompting a revision of all available specimens attributed to this classic taxon. Arguably the most complete is a partial cranium from the Cenomanian–middle Turonian of Dorking, England. This has been dubbed the 'Dorking specimen', and was first described in 1860 by Sir Richard Owen, who referred it to *Polyptychodon interruptus*. Its historical association has also subsequently prompted suggestions that the specimen be designated the neotype of *P. interruptus*. Though incomplete, its morphology allows for comparisons with other brachauchenines, suggesting its potentially distinct nature. The phylogenetic placement of the specimen further supports the affinity with other Late Cretaceous brachauchenine pliosaurids, which clearly occupied apex-predator niches in marine ecosystems (including those of Europe) up until the end of the Turonian.

ID 280

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Anatomy and phylogeny of a New, Peculiar Species of *Saurichthys* from Monte San Giorgio (Ticino, Switzerland)

Poster Presentation

European Fossil Fish Symposium

Saurichthys (Actinopterygii, Osteichthyes) is an iconic Triassic genus, characterized by a highly specialized morphology. Over 40 species of this ambush predator are known from marine and freshwater localities worldwide. Of these, six species have been previously described from marine Middle Triassic beds of the UNESCO World Heritage Site Monte San Giorgio (Canton Ticino, Switzerland and Lombardy, Italy). Recent, systematic excavations in a newly-discovered, fossiliferous interval of the Meride Limestone (Sceltrich beds, Ladinian), brought to light several new specimens of *Saurichthys*. The material includes complete individuals, mostly belonging to a new species with a peculiar anatomy. The new species resembles *Saurichthys curionii*, known only from older beds of Monte San Giorgio, in many characters, but it is clearly distinct from the latter in several features. The new species is characterized by unsegmented paired and unpaired fins with branched lepidotrichia, presence of ossified haemal spines in the whole axial skeleton, and diamond-shaped mid-lateral scales. A cladistic analysis is presented to reveal the interrelationships of the new species from the Sceltrich beds.

ID 260

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Carcharodontosaurian evidence in the Upper Jurassic of Portugal: Filling the Gap

Poster Presentation

A new carcharodontosaurian theropod from the Upper Jurassic of the Lusitanian Basin is here discussed. This new carcharodontosaurian is represented by two specimens, SHN.019 and SHN.036, collected in sediments from the upper Tithonian and upper Kimmeridgian–lower Tithonian, respectively. These specimens share with other carcharodontosaurian theropods some synapomorphies, including the presence of a well-developed ventral ridge in the anterior caudal centra, the anteroposterior length of the pubic distal expansion being more than 60% of the pubic shaft length, the iliac articular surface of the ischium is deeply concave, and the ventrally rather than anteroventrally oriented pubic peduncle. In addition, they share an unusual combination of features with some carcharodontosaurians such as *Neovenator* and *Acrocanthosaurus*, including the presence of a robust suboval eminence on the lateral

surface of the lesser trochanter and the well-developed and rugose depression in the medial surface adjacent to the fourth trochanter. With the exception of some isolated teeth, these specimens represent the oldest evidence of carcharodontosaurian theropods in the Laurasian record and provide relevant information to fill the gap on the early radiation of the group. The presence of Carcharodontosauria in the Iberian Peninsula, and the apparent absence of this clade in correlative North American strata, contrasts with the recognized faunal similarity among both sides of the proto-North Atlantic during the Late Jurassic. A similar situation also occurs with other groups of dinosaurs such as dacentrurines and turiasaurs. These differences in the higher-taxonomic composition of the theropod dinosaur faunas may be explained by differential patterns of regional extinction and/or local environmental preferences.

ID 240

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Five Minutes Per Bone - Mass Digitizing Dinosaur Bones in Lufeng, China

Oral Presentation

There are a plethora of vertebrate collections all over the world that are difficult or expensive to access for the vast majority of researchers. Many research projects do not require access to the physical fossils, but can be performed using high-resolution 3D models of them. However, such models only exist for a negligible minority of fossils. Therefore, much time, effort and funding can be saved if novel scanning methods accelerate the generation of 3D data. Here, I report on a visit to the World Dinosaur Valley museum in Lufeng, China, where a large number of partial to complete specimens of Triassic and Jurassic dinosaurs are on exhibit. During a stay of 8 work days, 5 days were spent capturing data to generate high resolution models (resolution better than 0.1 mm; scale deviation <0.2mm/m) of nearly 400 specimens, comprising nearly 480 bones. The equipment used costs less than 1200 EUR, and freeware or commercial software sold at discount to educational institutions can be used to create photogrammetric models. Although the Lufeng fossils are uniquely suited for rapid digitizing, many other collections are also candidates for rapid photogrammetric digitizing, at slightly lower rates. If similar data capture efforts are performed by only 10% of researchers visiting collections and the resulting files made available through the institutions housing the fossils, the vertpalaeo community can create a representative 3D database of important fossils within a decade, opening up new research approaches and, along the way, creating a virtual 'backup' of key specimens.

ID 171

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The Phylogenetic Relationships and Evolutionary History of Titanosauriform Sauropod Dinosaurs

Oral Presentation

Titanosauriforms represent the most diverse clade of sauropod dinosaurs, with >120 species, a global distribution, and a Late Jurassic to end-Cretaceous temporal range. Interrelationships of this clade are poorly understood, especially for derived titanosaurs; however, a wealth of new data provides an opportunity to remedy this problem. Based on first-hand study of taxa and an extensive review of the literature, here we present a revised phylogenetic analysis focused on titanosauriforms, comprising 88 taxa (including 30 titanosaurs) scored for 451 characters, many of which are novel to this study. After pruning several unstable and highly incomplete taxa, analysis in TNT produces a fairly well-resolved topology. The 'French *Bothriospondylus*' is recognised as a new genus of brachiosaurid, and is the earliest known (Oxfordian) titanosauriform. A putative South American brachiosaurid (*Padillasaurus*) is instead recovered as a somphospondylan. Many analyses, including previous iterations of this matrix, have recovered a titanosaurian clade consisting of taxa known primarily from skulls. Our results place *Sarmientosaurus* as a basal titanosaur and remove *Rapetosaurus* from Nemegtosauridae, although *Tapuiasaurus* is still allied with the latter clade. We recover a diverse clade of Late Cretaceous South American (including *Antarctosaurus*, *Epachthosaurus* and *Mendozasaurus*) and Indo-Madagascan (*Jainosaurus*, *Vahiny*) lithostrotian titanosaurs. The latest Cretaceous Eurasian taxa *Lirainosaurus* and *Opisthocoelicaudia* cluster with the North American *Alamosaurus*, nested within a clade of South American (including *Aeolosaurus*, *Baurutitan* and *Saltasaurus*) and Indo-Madagascan (*Ixisaurus*, *Rapetosaurus*) lithostrotians. Biogeographic analysis indicates that many titanosaur lineages were widespread by the late Early Cretaceous, with regional extinctions leading to continent-scale endemism.

ID 167

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Inferring Locomotor Behaviours in Miocene New World Monkeys: A Comparative Finite Element Analysis of the Platyrrhine Talus*Oral Presentation**Symposium: Ecomorphology and Functional Anatomy
in Vertebrate Palaeontology*

Platyrrhines occupy a diverse range of niches in the Americas. The occupation of these diverse habitats has been accompanied by distinct locomotor, behavioural, morphological, and ecological adaptations. The talus is probably the most commonly preserved post-cranial element in the platyrrhine fossil record, being preserved in several Miocene taxa. It has been proposed that studying the talus is important because its morphology could provide information regarding postural and/or locomotor adaptations since this bone is responsible for transmitting body mass forces from the leg to the foot, as well as providing stability and mobility throughout locomotion. Therefore, analysing talar biomechanical performance could be a useful way to infer locomotor and/or postural repertoires in extinct species. A comparative Finite Element Analysis (FEA) was carried out to study the biomechanical behaviour of the talus in 40 extant platyrrhine species to test if it was possible to distinguish locomotor behaviours (i.e. suspension, quadrupedalism and leaping). Our results show that climbers exhibit higher stresses, quadrupedals medium values and leapers the lower stress values among platyrrhines. We found significant differences between the different locomotor categories by applying a Kruskal-Wallis test with Holm correction, thus it is possible to distinguish these main locomotor behaviours using FEA. Then, we analysed ten different Miocene fossil samples to compare their stress results with the extant data to infer their possible locomotor behaviours. Most of the fossil samples show values indicative of quadrupedal locomotion.

ID 154

Ryan D. **Marek**¹, Karl T. Bates¹, Peter L. Falkingham²¹ University of Liverpool, UK² Liverpool John Moores University, UK
rdmarek@liverpool.ac.uk**Regionalisation of the Avian Cervical Column: A Link between Morphology and Ecology***Oral Presentation, Student Contribution**Symposium: Ecomorphology and Functional Anatomy
in Vertebrate Palaeontology*

Birds have evolved powerful forelimbs that are used in flight. This has rendered these appendages less useful for environmental manipulation than in many of their dinosaurian antecedents. Reliance on the head/neck for feeding and environmental interaction places high selective pressure on cervical form-function potentially explaining the diversity in avian neck morphology. To date there has been no systematic study of morphological diversity in the avian neck and correlation with feeding habits. We use a combination of three-dimensional geometric morphometrics (GMM) and qualitative character coding to assess regionalisation within the cervical column of a variety of extant birds. These species represent a diverse array of feeding and functional ecology, cervical count (12-17) and body size. Results provide strong support for 5 cervical subregions (axis, anterior, middle, midposterior, posterior) in all species. The atlas subregion appears to show the strongest signal, with the axis being clearly separate in all studied birds, possibly owing to its function in head stabilisation. Other subregions with a stable cervical count (anterior and posterior) also display a clear functional role. The remaining 2 regions (middle, midposterior) show much variability in cervical count between species (middle 2-6 cervicals, midposterior 1-4 cervicals). These results suggest that whilst the underlying Hox genes may restrict avians to 5 cervical subregions, expansive variability in the middle and midposterior regions allow the cervical columns of birds to adapt to many different functional ecologies, and may be responsible for the large variety of neck morphologies observed in extant Aves.

ID 242

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Palaeoenvironmental Changes Around the Paleogene/Neogene Border in Central Mongolia (Valley Of Lakes) as Inferred from the Mammal Assemblages During 11 My of Evolution

Oral Presentation

Today Central Mongolia is characterized by a desert continental climate associated with cold steppe vegetation, but the onset of these arid conditions has been a topic of discussion through many previous publications. Since 1995, successive joint Austrian-Mongolian projects in the Taatsiin-Gol area in Mongolia have assembled a collection of fossil mammals including 19,042 specimens from 60 layers, from the Early Oligocene to the Early Miocene. Mammal assemblages reveal significant changes in diversity and composition, especially for the species richness, which varies from 31 to 73 species at layer-level. Analysis based on the structure of the whole mammalian communities and the compositions of glires assemblages allow the reconstruction of the evolution of environments. Results show that late Early Oligocene and the beginning of the Late Oligocene [c. 33-26 Ma] are characterized by a subtropical-to-tropical semi-humid climate with a vegetation mainly composed of seasonal broadleaf forest (including an extended dry season), with a maximum of temperature and humidity around c. 28.4 Ma. During the Late Oligocene [c. 26-24.5 Ma], conditions are dryer with a noticeable decrease of temperatures. By the end of the Oligocene the climate becomes temperate, associated with more open vegetation. At the beginning of the Miocene temperatures re-increase with a second step toward aridity, but still far from being desertic as today. Correlations between the different datasets confirm the influence of the global climate over local environments but suggest that the elevation of the north Tibetan Plateau might be a more important controlling factor from c. 25 Ma onwards.

ID 256

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Can the Shape of the Calcaneus Help Us Interpret Locomotion in Extinct Primates?

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy in Vertebrate Palaeontology

The calcaneus of extinct primates has been used to infer locomotor behavior in fossil forms. In this study, we use 3D GM in order to assess the phylogenetic signal of the calcaneus as well as evaluating the covariation that exists between its shape and the type of locomotion, specifically the proclivity for leaping, and support use, in extant strepsirrhines. To do so, we use 3D surface reconstructions from MorphoSource and locomotion and support use data from Oxnard and collaborators. Geometric morphometric data were taken on 30 calcanei of different extant strepsirrhines. Our preliminary results show that the shape of the calcaneus has a moderately strong phylogenetic signal, and that body mass also has an effect on the shape of this bone. Locomotion and the tendency to leap have a strong phylogenetic signal. However, we find no significant phylogenetic signal for the type of support used during locomotion. The shape of the calcaneus and locomotion significantly covary within extant strepsirrhines, even when phylogeny is taken into account. The leaping strategy also covaries with the shape of the calcaneus, but only when phylogeny is not taken into account. Finally, support use and the shape of the calcaneus covary at a lesser degree than leaping and locomotor strategies. Thus, the shape of the calcaneus is not much affected by the type of support used in extant strepsirrhines, but it is affected by locomotor repertoire as well as leaping proclivity, even though the latter is more dependent on phylogeny.

ID 257

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Taphonomy in Microvertebrates: Recent or Ancient Alterations?

Poster Presentation

Microvertebrates constitute a powerful tool for the reconstruction of past environments. The remains are collected from the sites and then processed on site and/or at the laboratory. Different treatments have been developed in order to process these microfossils. For the disaggregation of the matrix, in which fossils are contained, different products can be used depending on the nature of the substrate. Hydrogen peroxide or kerosene treatment is used for shales, whereas, acids are used to remove the calcite in limestones, and other rocks. Also, ultrasonic baths can be used to clean any isolated pieces with little particles of sediment adhered to them. Those techniques that may affect the fossils, are known as taphic factors, which act in the last phase of the taphonomic history of the specimens.

In this work, we have explored the most common methods and treatments to prepare microfauna assemblages. The microfossil samples were examined under the binocular light microscope and the Scanning Electronic Microscopy, before and after the treatments. The aim of this work is to evaluate the action of the different treatments and methodologies used on the microfossil remains during the process in order to determine if they could be masking previous taphonomic modifications.

ID 267

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Preliminary Data Of Reptiles and Amphibians from El Salt Xb (Middle Palaeolithic; Alcoy, Spain): Palaeoclimatic Implications

Poster Presentation

The locality of El Salt (Middle Palaeolithic, Alcoy, Spain) is mainly known by having one of the youngest Neanderthal records of the Southeastern Iberian Peninsula. The upper part of stratigraphic unit Xb, dated at 52.3 ± 4.6 ka (MIS 3), is characterized by the presence of several archaeological assemblages, comprising vertebrate faunal remains, lithics elements and anthropogenically modified cobbles. The field campaign of 2013 in unit Xb, have yielded for the first time in this locality a small sample of amphibian and reptile remains. The faunal list for unit Xb is composed by: three taxa of anurans (*Alytes obstetricans*; *Bufo bufo* sensu lato and *Epidalea calamita*), one taxon of blaniid (*Blanus cinereus* sensu lato), two taxa of lizards (*Chalcides bedriagai* and cf. *Acanthodactylus erythrurus*) and one taxon of snakes (cf. *Rhinechis scalaris*). In order to reconstruct the climate at the moment of formation of the unit, we studied the current distribution of the reptiles and amphibians species described by using Mutual Ecogeographic Range (MER) methodology. Preliminary results obtained suggest a mean annual temperature of 14.5 ± 2.4 °C and a mean annual precipitation of 665.2 ± 219.6 mm. These results show a slightly warmer and

wetter climate than those recorded in Alcoy nowadays. The surrounding area of El Salt would be dominated by bushland and forest, alternating with open areas.

ID 235

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Taphonomic Study of Somosaguas-North (Madrid Basin, Spain), a Middle Miocene Mammalian Fossil Site Deposited by Debris Flows

Poster Presentation

Somosaguas-North (Madrid Basin, Spain) is a Middle Miocene mammalian fossil site embedded in debris-flow deposits. Very few debris-flow sites of Cenozoic age are known so an exhaustive taphonomic study of this site has been carried out in order to increase our knowledge about the formation of this type of assemblage. The deposits consist of matrix-supported, poorly-sorted coarse arkosic sandstones and fine conglomerates. A total of 6592 large-mammal remains have been retrieved, belonging to at least 10 different species. The most abundant taxa are the proboscidean *Gomphotherium angustidens* (11.92%) and the equid *Anchitherium cursor* (7.34%). Other taxa found at the site include the rhinocerotid *Prosantorhinus douvillei*, the suid *Retroporcus complutensis*, the moschid *Micromeryx* sp., the cervid *Heteroprox* sp., the bovid *Tethytragus* sp., the amphicyonid *Amphicyon* sp., the hemicyonid *Hemicyon* sp., and the felid *Pseudaelurus* sp. Although breakage is extremely common, well-preserved, complete to almost complete skeletal elements are also found. Bone remains are isolated, indicative of long exposure times (enabling decay and complete disarticulation). There are no associations of same-individual elements, suggesting that bones were

profusely dispersed before or during debris-flow transport. The predominance of weathering stages 0 and 1 indicates that most of the bones were exposed a maximum of 3 years before burial. Based on the taphonomic evidence, we suggest that Somosaguas-North assemblage was formed by successive debris-flow transport and burial of different pre-existing thanatocoenoses, with varying taphonomic characteristics depending on their exposure time.

ID 189

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Intraspecific Allometric Changes in the Skull of the Cave Bear (*Ursus spelaeus*)

Poster Presentation

Symposium: Recent Advances on the Palaeoecology, Evolution and Extinction of the Cave Bear

With an extensive fossil record, the cave bear (*Ursus spelaeus*) is one of the most well-known Pleistocene mammals. Despite this, it remains unexplored whether the cave bear follows the same allometric pattern than its living relative, the brown bear (*Ursus arctos*). Here, we investigate patterns of static allometry (among adult individuals) of the skull in the cave bear complex and the brown bear. To do this, we collected a large sample of skulls of *U. arctos*, *U. spelaeus* (including *U. s. spelaeus*, *U. s. ladinicus*, *U. s. eremus*) and *U. ingressus*. We located 3D landmarks on them and applied geometric morphometric methods. To study the correlation between skull shape and size, we performed a multivariate regression between Procrustes coordinates (shape) and log-transformed centroid size (size). The results obtained show that size increase is associated with a longer muzzle, anteriorly narrower zygomatic arches, a narrower occipital crest, and a shallower rostrum. These shape changes are very similar for both species. However, the cave bear complex is shifted positively in comparison with brown bears. This change indicates that for similar-sized skulls, the allometric features described above are more developed in the cave bear than in the brown bear. Moreover, the different species and subspecies included within the cave bear complex follow the same trend than the whole group. Our results indicate that the cave bear complex follow the same allometric pattern, and this is different from the one followed by brown bears.

ID 193

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European Affinities of the Late Triassic Biota from Greenland are Related to Paleolatitude

Oral Presentation

The discovery of *Cyclotosaurus naraserluki*, a new temnospondyl capitosaur from the late Norian-?early Rhaetian of the Fleming Fjord Formation, has raised paleobiogeographic questions on the affinities of the Late Triassic Greenland biota. This is because Greenland is part of the North American continent but all *Cyclotosaurus* species are restricted to Europe. Of the 21 taxa known from the Late Triassic of Greenland 9 are plants and 12 are vertebrates. Curiously, we failed to find evidence of Late Triassic invertebrates in literature from Greenland, though bivalves from the Fleming Fjord Formation were collected.

The closest relatives of each taxon show the following distribution: 10 from Europe (48%), 1 from Asia (5%), 1 from North America (5% - *Paratypothorax andressorum*), 8 cosmopolitan (38%, mainly plants), and 1 unclear (5% - *Mitredon cromptoni*). These figures provide an indication of the possible paleogeographic origin of the Late Triassic taxa and the most influential provinces. Despite the geographic position of Greenland as part of the North American plate, its Late Triassic fauna and flora show strong European affinities.

North American findings are from the Southern USA, at a tropical paleolatitude of 5–10°N, while most European findings are from a temperate paleolatitude of 34–44°N. The Jameson Land Basin lay at about 44°N during the Late Triassic, within the range of the northernmost European findings. The arid band controlled by the Hadley cell lay between the North American and European fossil sites. The dispersal of Triassic life was therefore strongly influenced by paleolatitudinal climate belts.

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Evolutionary Implications of the Ontogeny and Reproductive Biology of Saurichthyidae (Actinopterygii)

Oral Presentation

European Fossil Fish Symposium

Viviparity has evolved independently at least 12 times in ray-finned fishes. However, it has been reported only in two non-teleost actinopterygians, *Saurichthys curionii* and *S. macrocephalus*, both from the Middle Triassic Meride Limestone (Monte San Giorgio, Switzerland). We present new data on the reproductive biology of these species, giving unprecedented insights into their life-history. 67% of the adult fishes examined were female, and positional and preservational criteria identified 6 specimens as unambiguously gravid. Embryos were positioned with the skulls usually directed anteriorly, dorsal to the gastrointestinal tract, parallel to the axial skeleton and to each other, in the posterior 2/3 of the abdominal region. A minimum of 16 embryos are preserved in the most fecund females, and based on the largest preserved embryos and smallest preserved neonates, birth must have occurred at 7-12% of maternal fork length. Embryonic crania and teeth are relatively well-ossified. In the postcranium, the median scale rows and lepidotrichia are ossified, but not the lateral scale rows. Ossified squamation suggests that neonates did not undergo metamorphosis, and were relatively precocial. Viviparity is often associated with higher rates of speciation in fishes, due to increased dispersal abilities relative to demersal spawners, reducing competition for territories or nest sites, and more rapid post-zygotic reproductive isolation. Middle Triassic saurichthyids from the western Tethys, in particular, seem to show both high species diversity in sympatry and species-level divergence between coeval neighbouring basins. A better understanding of the reproductive biology of these fishes may help explain these patterns.

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New Statistical Models for Quantitative Palaeoclimatic Inferences of Spanish Miocene Fossil Sites

Oral Presentation

We developed new quantitative palaeoclimatic inference models based on the body size structure of mammal faunas from the Old World tropics, excluding carnivores and bats. Our analyses were based on multivariate and univariate regression models establishing the relationship among climatic data and body size structure of 63 modern assemblages along climatic gradients from Sub-Saharan Africa and the Indian subcontinent. We selected localities from this area because they have larger historical and evolutionary relationships with the Miocene faunas from Spain than those from other continents and represent all the possible biomes and ecotones from the evergreen equatorial forest, through semi-evergreen tropical forest, tropical deciduous woodland and savannah, to the tropical desert. The relationship among body size structure (measured in percentage histograms with 8 categories) and climatic variables (T, Tmin, Tmax, Mta, P, D) was studied for all the dataset and for the African and Asian subsets independently. Finally, we were able to find accurate models and validate it for the inference of mean temperature of the coldest month (based on African faunas), mean annual thermal amplitude (based on palaeotropical, African and Asian faunal subsets), as well as total annual precipitation and drought length (based on Asian faunas). We applied these models to body size structure of the Somosaguas fauna in order to obtain climatic values for this Miocene fossil site. Our results were congruent with previous works, which suggests that these models can be confidently used for inference of climatic parameters in other Miocene mammalian fossil sites from southern Europe.

ID 128

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Solving the Inner Ear Shape Conundrum: Ecology vs Phylogeny? Case of the Toothed Whales

Oral Presentation

Symposium: Ecomorphology and

Functional Anatomy in Vertebrate Palaeontology

The inner ear is the organ of balance and audition. Thus, many studies investigated if its morphology reflects ecological parameters (e.g., environment, locomotion, agility, auditory capacity). A known case study is the cetacean bony labyrinth. Semi-circular canal reduction apparently indicates an aquatic habitat and the angles of deviation from orthogonality could potentially characterize environmental preferences. Nevertheless, most of these analyses used *a posteriori* methodologies to 'discriminate' the ecological parameters. In addition, published hypotheses often lack phylogenetic control while recent studies demonstrated that bony labyrinth morphology is highly linked to phylogeny. Here we conduct the first extensive work on the bony labyrinth shape of Odontoceti (toothed whales) including 11 extant species from all living dolphin families (with 4 freshwater dolphin genera) and 11 fossil species, using 3D geometric morphometrics. Different protocols for sliding landmarks are applied to test their impact on the results. Through ordination methodologies, ecological, allometric, and phylogenetic signals of the Odontoceti bony labyrinth are tested. Contrary to previous observations, the Odontoceti semi-circular canal shape cannot be formally correlated with any of these parameters. Their reduced shape may not separate clades or environments. On the opposite side, cochlear shape is correlated with all the tested parameters. Indeed, shape and position of the secondary bony lamina as well as coiling help to separate the different families. The cochlea is the first structure to fully ossify during the ontogeny. Moreover, total length of the cochlea influences hearing frequencies that are directly linked to the environment and feeding strategies in marine environments.

ID 101

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The Norian Bonebeds of Northern Switzerland - 'Deep in the Motherlode - It's Falling Like Water, Always Coming Down From Those Hills'

Oral Presentation

Since its discovery in 1856 the locality of the first discovered Swiss dinosaur remains at Niederschönthal (BL) has almost fallen into oblivion. Similarly, the famous *Plateosaurus* locality in Frick (AG) was investigated in some detail but a sedimentological study supporting the 'miring' hypothesis was never undertaken. Here, we present first results of a sedimentologic and palaeontologic study of these localities. The bonebed-bearing strata form part of the Klettgau Formation (Gruhalde Member).

The Frick locality yields a mix of articulated, semi-articulated and isolated prosauropod bones in several fine-grained sandstone horizons. Bones are coated with hematite indicative of hydromorphic soils. Articulated turtles and fish in sand layers and caliche nodules below complete skeletons are not suggestive of death by miring. Furthermore, oolites on top of the bone beds (with miliolid foraminifera as nuclei) show marine influence. The underlying sediment layers have an erosive base and they are composed of reworked pedogenic carbonates and contain lungfish teeth. So far these observations point to deposition in channels. During floods already buried carcasses together with complete animals became reworked.

The ?coeval bonebeds from Niederschönthal contain a different fauna and flora (temnospondyls, hybodontid sharks, palaeoniscid fish, dipnoans, phytosaurs, aetosaurs, coprolites, wood, sphenophyte stem fragments). Charcoal in these samples provides the first evidence of forest fires. All in all they contain reworked faunal elements from mud flat playas, carbonate lakes or fluvial channels occurring within a wide seasonally dry alluvial plain.

ID 120

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New Information on the Feeding Habits of the Messel Percomorph *Rhenanoperca minuta*, Together with a Short Look at Other Messel Fish Species

Oral Presentation
European Fossil Fish Symposium

832 samples from four Messel fish species were investigated with respect to their gastric contents. Only 3.96% showed prey remains. In *Rhenanoperca minuta*, 5.23% of the samples contained conspecific prey. Concerning the other Messel fish species, 2.63% of the specimens of *Thaumatodus intermedius*, 6.66% of *Cyclurus kehreri*, and none of *Atractosteus messelensis* showed identifiable food remains.

In *Rhenanoperca minuta*, there are two different types of pharyngeal jaws. One with 'molariform' teeth, as in extant 'shell-crackers', and another one other with 'papilliform' ones, as in extant invertebrate and detritus feeders. The high rate of evacuated gastric tracts together with the occurrence of cannibalism may result from temporary shortages of suitable prey. 'Hard-shelled' food, like gastropods, is comparatively rare in the Messel fossil record. A diet switch from arthropods to fish, as it was reported in literature, cannot be confirmed by the present investigations. Only few specimens showed fish remains at all, and these most probably consisted of cannibalized prey. According to the pharyngeal jaw dentition, there rather was a switch from soft-bodied arthropods to gastropods. The polymorphism of the pharyngeal jaws may be ascribed to phenotypic plasticity and/or an ongoing speciation. The different morphotypes probably originated in adjacent water bodies rather than in Lake Messel itself.

Scarcity of suitable prey scarcely can be the reason for the high rate of evacuated gastric tracts in the other Messel fish species. Other factors, like diurnal or seasonal fluctuations in their general activities and food intake may have played a more important role.

ID 213

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New Primate Remains from a Middle Eocene Karstic Locality in Switzerland

Poster Presentation

The locality of La Verrerie de Roches (VDR) is a network of Middle Eocene fissure fillings located in the Jura Region

(Switzerland), known since the beginning of the 20th century. Several field campaigns mainly carried out in the 1970s led to the recovery of abundant mammal remains. Nevertheless, the primates from this site have never really been described in detail. Here we present a preliminary report of a new primate assemblage from this locality. The studied material includes more than 80 dental remains assigned to five different primates. The best represented genus is *Necrol-emur*; the form found in VDR is smaller than *N. antiquus* and closer in size and overall morphology to *N. anadoni*. Microchoerines are also represented by two species of *Pseudoloris*, constituting an unusual case of joint record of two forms of this genus. Remains of Adapiformes are limited to two isolated molars: one of them corresponds to an anchomomyin, morphologically similar to *Anchomomys* but clearly larger. The other tooth corresponds to an undetermined adapine. The studied primate association allows placing VDR between the MP15 and MP16 reference levels, although it probably indicates some degree of temporal mixing. This assemblage includes some microchoerines that up to date were only known from Spain. Their presence in Switzerland gives further support to previous hypotheses considering that the Pyrenean Basins were connected to Central Europe during the Middle Eocene. Funded by SNSF (IZK022_154449), MINECO/FEDER, UE (CGL2014-54373-P, IJCI-2015-26392) and Generalitat de Catalunya (CERCA Programme, 2014 SGR 416, GRC).

ID 198

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The Giant Extinct Pikas (Ochotonidae, Lagomorpha) of Gargano: Evaluating the Body Mass Shifts in Insular Evolutionary Lineages

Poster Presentation

In insular environments, large mammals become dwarfs while small ones become giants following the 'island rule'. The fossiliferous deposits of Terre Rosse (Gargano, Italy) have provided remains of a remarkable extinct fauna with the typical insular features. Two species of lagomorphs (*Prolagus apricenicus* and *P. imperialis*) were identified in many of the fissures, establishing extraordinary evolutionary lineages in which to study the 'island rule' from a paleontological perspective. With that aim, several measurements (length and diameters of epiphyses) were taken in fossil material housed at the Università di Firenze, including humeri (N=632), femora (N=230) and tibiae (N=228). Posteriorly, following described methodology, the body masses of the two *Prolagus* species were predicted in different fissures. *Prolagus apricenicus* increased its body mass by 33% between the

oldest fissures (ca. 160 g, F15 and F21a-b) and the youngest ones (ca. 215 g, F1 and F9); while *P. imperialis* almost doubled its initial size (ca. 470 g, F9; to ca. 760 g, SG and F32) throughout its insular evolution. A bimodal distribution of body masses was clearly observed in F9, suggesting the coexistence of the two species already at this fissure. The occurrence of *P. imperialis* (from F9 on) did not suppose a drop of size of *P. apricenicus*, as might be expected as they are competitors (grazers). This may be explained because following F1 fissure, grassland dwellers were favoured by an environmental change towards a drier habitat.

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ID 172

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Bone Histology of *Equus* from Mosbach Sands (Middle Pleistocene, Germany)

Poster Presentation

The family Equidae has been extensively studied in paleontology. The almost continuous fossil record of equid remains allows the tracking of evolutionary changes in the clade, making equids a paradigm of macroevolution. Along with other anatomical modifications, this group experienced a large-scale trend towards ever increasing body size during their evolutionary history, interrupted by repeated size decreases such as, for instance, those observed during the European Pleistocene. Body size is an important life history trait that depends to a great extent on ecological conditions. Also, it tightly correlates with and depends on other biological traits, such as longevity and growth rate, which can be inferred from the histological study of bones in fossil taxa. In a first attempt to describe the life history of a Middle Pleistocene horse, we studied the paleohistology of *Equus* cf. *mosbachensis* from Mosbacher Sande (Wiesbaden, Germany) in the context of body size. Two metacarpals and one metatarsal were histologically analyzed, while different dental and postcranial remains were measured to calculate the species' body mass. We obtained an estimated weight of approximately 590 kg for *E. cf. mosbachensis*. The same as in extant horses, fibrolamellar bone was the main primary tissue type found in both metapodials. However, a higher proportion of vascular canals were observed in *E. cf. mosbachensis*, suggesting a faster growth rate. The growth pattern of *E. cf. mosbachensis* was also reconstructed

from the study of cyclical bone growth marks, providing valuable insights about the growth and pace of life of this Pleistocene species.

ID 199

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Cranial Integration Patterns in Landbirds: Macroevolutionary and Ecomorphological Implications

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy in Vertebrate Palaeontology

The evolutionary plasticity of the avian beak is often lauded as one of the key innovations that led to the diverse radiation of birds from within non-avian theropods. The particular architecture of the avian skull and extraordinary variability of beak morphologies suggests that bird beaks evolved as separate evolutionary units. Yet recent research has challenged these views showing that cranial integration is prevalent in several avian lineages, or even in the whole crown group of birds. While cranial integration is a widespread phenomenon in vertebrate evolution, how alterations to this integration affect macroevolutionary and ecomorphological patterns is still poorly explored. Here we used shape analysis (geometric morphometrics) to test the evolutionary covariation between the beak and the posterior skull across the whole landbird clade (Inopinaves). We tested the strength of cranial integration at several evolutionary levels between all clades of landbirds, and pinpointed where shifts in the degree of integration have likely occurred. We found strong cranial integration within and between the majority of landbird clades and a conserved pattern of integration across many of them. Interestingly, we found that cranial integration significantly intensifies in parrots and oscine passerines (songbirds), but with much weaker levels of integration in the suboscines and basal songbirds, that sit phylogenetically between the other two clades. We propose that a key evolutionary mechanism in birds is the shifting strength of integration between craniofacial regions, which allows some clades to evolve and diversify more rapidly along particular axes of morphological change and thus access unique ecologies.

ID 124

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Evolution of the Dental Pattern of Ctenodactylidae (Rodentia, Mammalia) from Mongolia

Poster Presentation

The Valley of Lakes (Mongolia) is one of the best paleontological and sedimentological continental records of the Oligocene in Asia. The Oligocene is characterised by its global climatic instability. Studies carried out in the area shown that the progressive aridification during the Oligocene occurred in several steps. In fact, during the late Oligocene, successive aridification events occurred. The strongest decline in mammals' diversity can be related to a strong aridification period coincident with the maximum of the Late Oligocene Warming. This aridification had dramatic consequences not only on diversity decrease but also on the evolution of different taxa like ctenodactylids, well-represented rodents from early to late Oligocene. Ctenodactylids from early and middle Oligocene (*Kakaromys decessus*, *Huangomys frequens*, *Yindirtemys shevyreva*, *Y. aff. ulantatalensis*, *Tartaromys minor longidens*, *T. sigmodon*, and *T. plicidens*) are small-sized, with bunodont teeth, a relatively simple dental pattern, and a low height of the crown. At the contrary, late Oligocene ctenodactylids (*Yindirtemys deflexus* and *Y. suni*), are large-sized and exhibits a dental pattern characterized by a mesodont dentition with some degree of selenodonty, an intricate enamel folding and a temporal retardation on the eruption of the successive molars in the tooth row. We interpret those morphological changes as related to the environmental worsening. In this way, the peculiar dental morphology and eruption sequence of these large-sized ctenodactylids is towards relatively more durable dentition, a way to adapt to more arid environments. This evolutionary strategy was, nevertheless, unsuccessful in the long run, and *Yindirtemys* became extinct during early Miocene.

ID 126

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The Late Jurassic Shark *Palaeocarcharias* (Elasmobranchii, Neoselachii) – Dermal Cephalic Lobes, Functional Morphology of Teeth and Phylogenetic Position

Oral Presentation

European Fossil Fish Symposium

Palaeocarcharias is a prominent taxon among the neoselachian elasmobranchs of the Late Jurassic Plattenkalke of South Germany. It is known from a number of articulated specimens which are housed in public and private collections. It was described first by de Beaumont in 1960 who also established the single species *P. stromeri* based on three specimens from the Earliest Tithonian Konservat-Lagerstätte of the Eichstätt-Solnhofen area in Bavaria, South Germany. A new articulated specimen shows dermal cephalic lobes and the morphology of lateral and posterior teeth which were previously unknown in this shark. Dermal cephalic lobes are an autapomorphy of recent Orectolobidae (nurse sharks). The new order Palaeocarchariiformes and the new family Palaeocarchariidae are proposed for *P. stromeri*. An isolated tooth from the Guimarota coal mine in Portugal extend the stratigraphical range of *Palaeocarcharias* into the Kimmeridgian. Its palaeobiogeographical occurrence includes central and western Europa. A Bayesian analysis shows Palaeocarchariiformes nov. ord. as the sister of Lamniformes/Carcharhiniformes with both clades forming a sistergroup relationship with the Orectolobiformes. The Palaeocarchariiformes are possibly of Middle Jurassic (Bathonian) age as indicated by the geological age of its sister Lamniformes/Carcharhiniformes. *P. stromeri* is morphologically intermediate between the Orectolobiformes and Lamniformes. It illustrates a scenario in terms of evolutionary ecology demonstrating the evolutionary path on which Lamniformes could have evolved from Jurassic Orectolobiformes.

ID 232

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Formation and Growth of Enamel in Non-Mammalian Cynodonts

Oral Presentation, Student Contribution

The evolution of mammalian morph from non-mammalian cynodonts is associated with the linked evolutionary origin of several important, typically mammalian characters, including diphyodont tooth replacement, mammal-like rapid juvenile growth and determinate adult growth. Histological techniques to assess periodic enamel increments have not previously been applied to non-mammalian cynodonts,

and are likely to improve understanding of the evolution of dental replacement and growth. We prepared histological thin sections of posterior postcanines from eight species of non-mammalian cynodont, and teeth from crown mammals and diapsids. Polarised light microscopy revealed two orders of incremental lines, resembling the daily laminations and longer period striae of Retzius of crown mammalian enamel, in all non-mammalian cynodont specimens. We used MANOVA to compare two measures of enamel growth, daily secretion rate (DSR) and crown extension rate (CER), in extant groups and in two non-mammalian cynodont groups, non-probainognathians and mammaliomorphs. CER was extremely high in non-probainognathians, in contrast with the gradual accretion of enamel in more crownward mammaliomorphs. This is consistent with the reduction in rates of dental replacement in mammaliomorphs, which would permit slower crown extension, while greater replacement rates in non-probainognathians may have required more rapid formation times. In addition, it is possible that the low ameloblast differentiation rate, which underlies low CER in mammaliomorphs, may be coupled with reduced osteoblast function. This would suggest reduced rates of bone growth during late molar formation in these animals, which would be consistent with a more mammal-like, abrupt termination of growth in mammaliomorphs in comparison with more basal cynodonts.

ID 294

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Body Mass Estimates of Extinct Terrestrial Birds Based on Osteological Measurements

Poster Presentation, Student Contribution

Body mass is an important parameter for approaches to reconstruct the biology of extinct bird species, as it correlates to many other biological parameters. Thus, several attempts to estimate body masses of extinct bird species have already been made. Both univariate and multivariate regression equations, based on osteological and body mass measurements of extant bird species, have been applied to obtain estimates of body masses for extinct bird species. However, to this date nobody has used a broad phylogenetic dataset, including ratites, to attempt to estimate the body mass of extinct terrestrial bird species. The existing reference datasets focus on aerial birds and, consequently, are very unlikely to yield reliable body mass estimates of extinct terrestrial species, such as, the dodo (*Raphus cucullatus*, L. 1758), moas (Dinornithiformes) or elephant birds (Aepyornithidae). Therefore, the main aim of this study is threefold:

first, obtain skeletal measurements and body masses for extant terrestrial birds; second, search for the osteological components that yield the best body mass estimates and calculate the regression equations; third, use these regression equations to obtain body mass estimates for the extinct Rodrigues solitaire (*Pezophaps solitaria* Gmelin 1789), a close relative of the famous dodo. This study also investigates how osteological measurements intercorrelate and how this varies behaviourally and phylogenetically, as well as whether there is an allometric signal in the scaling of osteological measurements. This study, thus, increases our understanding of the relationship between osteological measurements and body mass and, consequently, of the palaeobiology of these extinct terrestrial birds.

ID 313

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What Can the Claws of the Living Bird Hoatzin Tell Us about *Archaeopteryx*?

Poster Presentation

The hoatzin (*Opisthocomus hoazin*) was discovered in the 19th century but it is still an enigmatic bird nowadays. A classic case of conflicting hypotheses of phylogenetic relationships in avian systematics is provided by the hoatzin, supposed to be the most ancient bird lineage (64 million years) and which is unquestionably among the most curious and enigmatic of bird species in physiology, life history and anatomy. The nestling hoatzin may be best known for the presence of well-developed reptilian-like wing claws that are used to move among the branches of the nesting tree. When in danger, the young hoatzin jumps into the water, then uses its wing claws to climb back into the vegetation. The claws are lost in the adult stage. This unique feature among living birds leads to compare hoatzins with *Archaeopteryx*. The morphology of the hoatzin has not been studied since the first descriptions in the 19th century. The accurate anatomical study of a developmental series allows to describe the ontogeny of the morphological adaptation, and to compare the size of the wing claws to those of *Archaeopteryx*. It will give insight for understanding the functional adaptations and the history of this unusual bird.

ID 132

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Preliminary Report of a New Mammoth Record (Proboscidea, Elephantidae) from the Late Pleistocene of Hidalgo, Central Mexico

Poster Presentation

Mammoth remains were discovered near Ciudad Sahagún, state of Hidalgo, central Mexico. In this region Miocene to Pleistocene rock units crop out, including volcanic flows and heterogeneous volcanoclastic material that constitute gullies worn by water. In the town of San Jerónimo, the sedimentary deposits are of fluvial origin, consisting of volcanoclastic silt and sandstone. From these sediments was recovered the fossil material referable to mammoths. The fossil sample belongs to two individuals of mammoths. The most complete individual is represented by a disarticulated skeleton, including a partial upper jaw with M3, an almost complete defense, a complete humerus and femur, an ulna, several vertebrae, and rib fragments. The second individual is represented by two M3s and a broken defense. The features of the molars are those that distinguish the species *Mammuthus columbi*. This proboscidean inhabited areas that now are part Hidalgo in central Mexico during the late Pleistocene. Other fossil remains belonging to large-sized mammals have been recovered in the locality, including teeth of *Equus conversidens* and unidentified postcranial remains. Uranium-series dating will be performed on the mammoth bones, in order to provide information regarding the age of the fossil-bearing deposits. The mammoth record is the southernmost in the state of Hidalgo and complements the geographic distribution of *M. columbi* in the Trans-Mexican Volcanic Belt; furthermore, provides information about the composition of the late Pleistocene mammalian faunas in central Mexico. Further geological and paleoecological studies, such as stable isotopes, will provide data on the paleoenvironment of the region.

ID 263

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3D Geometric Morphometrics on the Hind Limb of the Titanosaurs from Lo Hueco: Dwarf Taxa or Small Individuals?

Oral Presentation, Student Contribution

The fossil site of Lo Hueco (Upper Cretaceous of Cuenca, Spain) has yielded an important sample of appendicular bones belonging to titanosaur sauropods. These elements were mainly found isolated, but also in association with partially articulated skeletons. Relative to the preservation, in many of these elements, the proximal or distal ends are poorly preserved obscuring important information from characters with taxonomic signal. Previous studies identified at least two distinct morphotypes based on skull, teeth, femoral and humeral material, corresponding at least to two mid-sized titanosaur sauropod (one of them, the exclusive form *Lohuecotitan panda-filandi*). In addition, some small appendicular and axial elements from Lo Hueco suggest for presence of a dwarf form or small individuals from the already known taxa. 3D geometric morphometrics comprises a powerful framework that can be applied to study the variation of the titanosaur appendicular skeleton. The use of landmarks and semilandmarks permits the exploration of the variability in the femora, tibiae and fibulae of the proposed morphotypes from Lo Hueco titanosaur. Canonical Variate Analysis (CVA) of the type 1 and 2 landmarks shows congruent results to the previously established morphotypes. A detailed description also notes several differences observed between appendicular elements which CVA results permit to interpret as pertaining to intraspecific variation and others to taxonomic variability. A preliminary Partial Least Square (PLS) analysis of the morphology of the hind limb allows assessing the covariation between its elements in the sample from Lo Hueco.

ID 264

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Comparison Between Classification Methods for Isolated Appendicular Titanosaur Bones

Poster Presentation, Student Contribution

Titanosaur sauropods were a highly diverse group of dinosaurs in the Ibero-Armorican Upper Cretaceous. The proposed sauropod diversity equals or surpasses those proposed for the high diversity in the Upper Jurassic of the Iberian Peninsula. However, some of the information of the *Ibero-Armorican titanosaurs* come from isolated elements. The scarcity of characters as well as the absence of relationship between parts of the skeleton renders the exploration of this diversity rather difficult. Assessing the overall number of different taxa or morphotypes is important to achieve conclusion on aspects such as its paleoecology. Discriminant analyses have been used as a helpful tool with other isolated and sometimes abundant dinosaur remains such as theropod teeth. In this sense, there is a huge available sample of appendicular elements of Ibero-Armorican titanosaurs, and particularly femora. However, as some studies imply, morphometric data of derived sauropod appendicular elements do not satisfy normality criteria. Indeed, albeit having a conservative bauplan, preliminary comparisons show high variability that complicates the application of some statistics such as the traditional discriminant analyses. Here some analyses covering Linear Discriminant Analyses (LDA) and Canonical Variate Analyses (CVA) are presented in order to help assign the isolated femora to corresponding titanosaur genera. Also, as sauropod fossil records yield uneven groups, the resulting sample has a heterogeneous N. It is proposed the use of Support Vector Machines as an alternative unbiased method for classification.

ID 147

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Pathological Survey of *Temnodontosaurus* from the Early Jurassic of Southern Germany

Oral Presentation

Paleopathologies document ancient skeletal damage and can be used to infer the causes of injury, as well as aspects of related biology, ecology and behavior. Few studies have been undertaken on Jurassic marine reptiles, and ichthyosaur pathologies in particular have never been evaluated at a generic level. Here we survey 51 specimens from the Early Jurassic of southern Germany that have been referred to the large macropredatory ichthyosaur

Temnodontosaurus in order to document and analyze the frequency and type of pathologies. According to our analysis, most observed pathologies in *Temnodontosaurus* are injury-related traumas with signs of healing. Broken ribs are correlated with other pathological bone modifications in the skeleton, especially injuries to the skull. Observed cranial pathologies are similar to those reported for extinct cetaceans and mosasaurs, which have been interpreted as resulting from aggressive encounters with conspecifics. Unlike other marine amniote clades, *Temnodontosaurus* lack evidence of pathologies affecting the vertebral column. This may indicate functional differentiation of the axial skeleton in ichthyosaurs relative to other large secondarily aquatic apex-predators. The absence of avascular necrosis in the German material referred to *Temnodontosaurus* is notable and might reflect specific or population level variation in habitat relative to generic equivalents between the European epicontinental basins and England. This study is intended to document the type and frequency of pathologies in large ichthyosaurs occupying the 'apex predator' niche, and may provide a window into the behavior of these animals when compared to other ichthyosaurs and marine tetrapods.

ID 244

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Ankylosaur Remains from La Cantalera Bonebed, Teruel, Spain (Early Barremian, Early Cretaceous)

Poster Presentation

Ankylosauria is an ornithischian clade fairly common in Laurasia since the Aptian, but there are few taxa described in the Early Cretaceous, usually represented by fragmentary material since the Middle Jurassic. The ankylosaur record from the Lower Cretaceous of Spain is scarce in contrast to other ornithischian groups (i.e. Ornithomimidae). Apart from two partial articulated skeletons recently found in the Lower Albian Escucha Formation of Teruel - assigned to *Europelta carbonensis* - the remains are relatively uninformative. In the last years some new ankylosaur remains from the early Barremian have been recovered in several fossil localities from the Blesa Formation (Teruel, Spain). Most of the material comes from La Cantalera outcrop (municipality of Josa). La Cantalera is a bonebed formed by attritional accumulation and concentration of disarticulated skeletal elements within low-energy depositional settings, more specifically, on a poorly drained floodplain. The new remains consist of a presacral spine, a caudal plate, osteoderms, a caudal vertebra, as well as additional material still in preparation

from other sites of the same unit. The dermal plates display morphology similar to that described for the remains of *Polacanthus* from the Iberian Peninsula, and together with the previous description of polacanthid teeth in La Cantalera, the new material has been tentatively assigned to Polacanthidae indet.

ID 196

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A Landmark Point Based Geometric Morphometric Approach and its Application in Tracking Evolutionary Changes within Genus *Microtus*

Poster Presentation

Symposium: Ecomorphology and Functional Anatomy
in Vertebrate Palaeontology

Voles have intricately folded molar enamel. The alternating indentations on both sides separate the triangles. With the successive infolding of the anterior cap, new triangles emerged in several lineages. Due to this process, the occlusal outline of the lower first molar varies among the taxa, and is usually a key feature for species-level identification. The present work introduces a landmark-based system, which can be used for comparing lower first molars that represent distinct evolutionary stages with different triangle counts (such as the three subgenera of *Microtus*: *Allophaiomys*, *Terricola* and *Microtus*). Only the salient and re-entrant angles (up to the fifth triangle), plus the most anterior and posterior ends of a tooth were considered here landmarks. Six additional sliding semi-landmarks were added to the cap, and one between each adjacent landmark below the cap. Furthermore, conventional measurements can be made using the raw coordinates of the non-sliding landmarks in order to obtain results, which are comparable with the parametric data available in the literature. Group structure can be evaluated via clustering. Principal components and discriminant analyses can be used for assessing intraspecific variability and for revealing the underlying factors behind the grouping. The above described approach was tested on voles belonging to genus *Microtus* from Hungarian Early to Middle Pleistocene sites, completed with recent material. The methodology proved to be a reliable basis for establishing evolutionary lineages within the genus by both tracking the changes of shape and size and also considering the stratigraphic succession of the studied localities.

ID 309

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On the Flight Metabolic Balance of the Largest Known Pterosaur, *Quetzalcoatlus northropi* (Pterodactyloidea; Azhdarchidae)

Oral Presentation

Estimates on the body mass and wingspan of *Quetzalcoatlus northropi* have sparked some controversy, some researchers concluding that it weighted over 500 kg and lacked power to fly. More recent estimates have agreed that the largest individuals (11 m wingspan) weighed up to 250 kg. Mathematical modelling of available metabolic power (P_{av}) and mechanical power required for active flight (P_{mech}) are presented for *Quetzalcoatlus* and *Vultur gryphus* (11,7 kg in weight) for comparison. Following previous works, $P_{av} = 47.126M^{0.605}$, where M is body mass; and $P_{mech} = P_{par} + P_{ind} + P_{pro}$, where P_{par} is parasite power, P_{ind} is induced power, and P_{pro} is profile power; being $P_{par} = 0.5\rho a S C_{dbody} V^3$; $P_{ind} = (2kM^2g^2)/\pi W^2V$; and $P_{pro} = 1.2(P_{par} + P_{ind})$; where ρ is air density, S is frontal body area, C_{dbody} is the body drag coefficient, V is velocity, k is the induced velocity scaling factor of lift generation, and g is gravity. For *Quetzalcoatlus*, $P_{av} = 1162.5$ W and $P_{mech} = 4862.6$ W; and for *Vultur*, $P_{av} = 208.7$ W and $P_{mech} = 259$ W, as if both were flightless. The methodology for estimating available power therefore needs a revision. We propose that the available power for flight could alternatively be estimated as $P_{av} = M \cdot FMR \cdot P_{o,m}$, where FMR is flight muscle ratio and $P_{o,m}$ is muscle power output. This new approach results in a power range of 4250–5750 W for *Q. northropi* and 199–269 W for *Vultur*. The result for *Vultur* thus validates the method, which in turn indicates *Quetzalcoatlus* had enough power to fly indeed.

ID 185

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A Unique Oreochromine Cichlid from the Ngorora Fish Lagerstätte Kabchore (Middle Miocene, Central Kenya)

Oral Presentation
European Fossil Fish Symposium

We present a new species of cichlid fish (Cichlidae: Pseudocrenilabrinae) based on eight excellently preserved skeletons. The material was discovered during fieldwork in 2013 from the 12.5 Ma-old site Kabchore of the Ngorora fish Lagerstätte located in the Tugen Hills of Central Kenya. The new fossil appears to be closely related to the modern genus *Alcolapia* Thys van den Audenaerde, 1969, one of several lineages of the Oreochromini. Shared characters are a comparatively slender body form, tricuspid teeth, a single predorsal bone, four lacrimal tubules, two lateral line segments, cycloid scales, and meristic counts including the number of dorsal fin spines and rays (XIII–XIV + 9–11 vs. IX–XV + 9–15 in *Alcolapia*), anal fin spines and rays (III + 8–10 vs. II–IV + 8–12 in *Alcolapia*) and the total number of vertebrae (28–30 vs. 27–30 in *Alcolapia*). The last dorsal fin spine is associated to vertebrae 12–14 (vs. 11–15 in *Alcolapia*), the ratio of the length of the first anal fin spine relative to the length of the last anal fin spine is 45–53% (*Alcolapia* 38–54%). The fossil was found in a freshwater setting, as evidenced by limestones and absence of extensive silification. However, modern species of *Alcolapia* are endemic to soda lakes in Tanzania and Kenya. This may indicate that the ancestor of modern *Alcolapia* has evolved in a lacustrine setting and that the adaptation to alkaline environments had not yet happened 12.5 Ma ago.

ID 211

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Feeding Performance in the Cave Bear (*Ursus spelaeus*) Cranium as Revealed by 3D Patterns of Bone Thickness

Oral Presentation
Symposium: Recent Advances on the Palaeoecology,
Evolution and Extinction of the Cave Bear

Abundant fossil remains of the cave bear (*Ursus spelaeus* sensu lato) from the Pleistocene of Eurasia have provided crucial insights to understand the ecological connections of ancient modern humans with large coeval carnivores. Therefore, disentangling the cave bear diet could give essential clues to further understand 'human-carnivore' interactions in ice-age ecosystems, and potential causes of its extinction. Despite this, the feeding preferences of the

cave bear are still controversial. In this study, we apply a novel virtual and non-invasive method to estimate areas of trabecular and cortical bone across the skull of living bears to make inferences on the controversial feeding behaviour of the cave bear (*U. s. spelaeus*). Whereas trabecular bone is well suited to deal with continuous and repetitive loads, cortical bone is better able to dissipate larger, more localized stresses. Our results indicate that those bears with a durophagous diet have thicker cortical bone across their skulls, the giant panda (*Ailuropoda melanoleuca*) being the species with the thickest one. In contrast, the sloth bear (*U. ursinus*), which has a very soft diet, based on insects, has the thinnest cortical bone. The profile of both cortical and trabecular bone of the cave bear is very similar to the profile of its closest living relative, the brown bear (*U. arctos*), which is probably the result of shared ancestry. In addition, our results do not support previous hypotheses on possible bone-cracking or hypercarnivorous habits for the cave bear.

ID 191

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Intraspecific Shape Modularity in Extant Bears and the Extinct Cave Bear (*Ursus spelaeus*): Implications for Internal Anatomy

Poster Presentation
Symposium: Recent Advances on the Palaeoecology,
Evolution and Extinction of the Cave Bear

The shape variability of the internal skull structures (i.e., sinuses and/or brain) of the cave bear is difficult to study because it is necessary to perform CT scans, which are difficult and expensive. Accordingly, while the external morphology of the cave bear cranium has been the subject of many morphometric studies, its internal structures have been comparatively less studied. Here, we explore sinuses and brain shape variation related to external skull shape modularity in all living bear species plus the cave bear, and we assess if these internal structures of the skull could be studied analysing solely the external shape. To do this, we digitized a set of landmarks in 3D from the external surface of the cranium in a wide sample of living bears and in the cave bear. We also CT scanned the crania of seven bear species. We performed a two-block partial least squares analysis (2B-PLS) to explore the intraspecific (static) morphological changes associated with the covariation between the splanchnocranium vs. neurocranium. Our results show that the first two PLS axes are associated externally with changes in the basicranium, face and cranium height and

width. There are parallel changes in dorso-ventral and medio-lateral expansion of sinuses and brain. Our results suggest the possibility to study the internal structures of cave bears using solely its external shape. This new approach opens the possibility to study the phenotypic shape variation of the internal structures in the cave bear complex.

ID 303

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A Three-Dimensional Analysis of Tooth-Root Morphology in Living Bears and Implications of Feeding Behaviour in the Cave Bear (*Ursus spelaeus*)

Poster Presentation

Symposium: Recent Advances on the Palaeoecology, Evolution and Extinction of the Cave Bear

The dental study from the occlusal area and the area between the root and the dental crown in bears, has allowed to analyze the relationship between bite force and diet. In order to make inferences on the cave bear (*Ursus spelaeus spelaeus*) diet, we analyzed from CT scans of crania of the 8 species of living bears (*Ursus arctos*, *U. americanus*, *U. maritimus*, *U. thibetanus*, *U.*, *Helarctos malayanus*, *Tremarctos ornatus* and *Ailuropoda melanoleuca*, plus two species of extinct cave bears (*U. s. spelaeus* and *U. s. ladanicus*). Our results indicate that all living bear species share a similar pattern of these areas, and therefore, a similar pattern between bite force and diet. The sole exception is the giant panda, *Ailuropoda melanoleuca*, which shows an opposite pattern, probably related with its specialized ecology. The dental pattern of the cave bear shares the same pattern of all living bears, specifically between *U. arctos* and *U. maritimus*, which seem to be related to shared ancestry. However, subtle differences between these three taxa could also indicate differences in their diets.

ID 151

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A Glimpse into the Past – Reconstructing the Lifestyle of Fossil Squirrels (Rodentia, Mammalia) Based on the Anatomy of the Vestibular System

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy in Vertebrate Palaeontology

Orientation in three-dimensional space is detected by the vestibular system of the inner ear, more precisely by the three semicircular canals. These canals are located in the bony labyrinth of the petrosal bone of the skull and can therefore be examined in both extant and fossil species. In 1873, Hyrtl denied any locomotory evidence in the anatomy of the vestibular system. But since the benefits of non-invasive micro-CT scanning and 3D reconstruction software became quite popular in recent years, many different studies were proven the opposite.

This study focuses on the reconstruction of lifestyles of fossil sciurids by using published data of extant squirrels representing a great diversity of locomotory adaptations (subterranean, fossorial, arboreal, gliding). After regression analyses and the corresponding standardisation of 3D measurements from the bony labyrinth with the condylobasal length, a principal component analyses was carried out.

The main functional-morphological distinction of the bony labyrinth between the different locomotory adaptations has been observed in the diameter of the semicircular canals. An Oligocene representative of †*Heteroxerus costatus* (Xerini) clusters in the morphospace of species with arboreal and fossorial adaptations. The Miocene †*Palaeosciurus feignouxii* (Sciurini) and an Oligocene member of †*Ischyromys typus* (Ischyromyidae) cluster outside and separated from the morphospaces of all other studied taxa.

ID 119

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Deinother Data Base

Poster Presentation

Deinotheriidae (extinct lophodont Proboscidea) originated in Africa (Oligocene), dispersed to Eurasia (Early Miocene) then went extinct there during the Early Pliocene, hanging on in Africa (Early Pleistocene). 4656 teeth have been identified, photographed and measured from 41 countries. Gaps in the data base are due to undescribed fossils in museum drawers. The data base consists of three categories of dossiers: A) Spreadsheet with institution, catalogue number, tooth, side, length, breadth, locality, age, comments; B) Dossiers arranged by institution containing images; C) Bibliography. Deinotheres taxonomy suggests that distinct lineages increased in size independently in Africa, Europe and Asia : this is unlikely. Authors employed geographic separation as a criterion for erecting new species, without considering morphometrics. Data reveals contemporaneous size increase throughout the Old World indicating the possibility of relatively free gene flow between the three continents throughout the Miocene. Deinotheres were obligate folivores which suggests that from 20 - 8 Ma, sub-tropical climatic conditions extended well north of their current position. Re-identification of teeth was required (deciduous teeth mis-identified as permanent teeth). Inferred presence of two species of deinotheres at a few localities was based on mis-identified teeth, or mixed samples or small samples containing the lower and upper ends of the ranges of variation of single species (sexual bimodality was low). Data indicate that two species of deinotheres never occupied the same geographic zone. The unit-fauna hypothesis of Rhine Graben deposits, is refuted : previously correlated to MN 9, they span MN 4 to MN 11.

ID 259

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New Morphometric Insights into the Knee Joint Complex of *Epipliopithecus vindobonensis*

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy
in Vertebrate Palaeontology

Epipliopithecus vindobonensis is considered a stem putative catarrhine that has been placed within the Pliopithecinae. Several skeletons and isolated remains belonging to at least three individuals were found at the beginning of the 20th century in Děvínská Nová Ves (Slovakia) and dated in the early Middle Miocene. Apart from the first descriptive works and some recent studies focused on its forelimb remains, low attention has been paid to this spectacular

discovery. The completeness and impressive preservation of the unearthed remains open the possibility of responding uncountable questions about the positional behavior of this taxon. Hence, this work focuses on studying the knee of *Epipliopithecus* as a morphological complex, including the distal femur, the patella, and the proximal tibia within a wide comparative framework. Thus, multivariate statistical analyses reveal that the external shape of the *Epipliopithecus* knee is essentially similar to that of platyrrhines and cercopithecoids (especially colobines), and to hylobatids to some extent. These similarities are underpinned when the shape of the distal femur and the proximal tibia are analyzed separately. Interestingly, the morphology of the patella clearly resembles that of extant gibbons. Therefore, mixed morphological resemblances with anthropoid monkeys and hylobatids indicate that *Epipliopithecus* might have a knee adapted to diverse joint positions, showing primitive features which suggest preferential movements in the parasagittal plane. As previously hypothesized, this set of external traits indicates that this taxon might combine several locomotor modes within its positional behavior repertoire, mainly including agile arboreal quadrupedalism, but also climbing, leaping, and even limb suspension.

ID 245

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Evolution of the Vascular Pattern in Mammals: Using Synchrotron Imaging to Visualise Hidden 3D Structures

Oral Presentation

The morphology and histology of long bones are important tools for understanding tetrapod locomotion and growth. In mammals, the epiphyses of long bones ossify from a secondary centre of ossification. The consensus is that vascular canals are closely tied to the formation of these centres. However, the epiphyseal vascular organisation differs significantly between each major clade of mammals: Eutheria, Metatheria and Monotremata. Previous studies on the distribution of canals mainly examined 2D thin-sections, which has led to inaccurate interpretations of their three-dimensionality. This study uses propagation phase-contrast X-ray microtomography to visualise the epiphyseal vascularisation of humeri from the eutherian *Dasypus novemcinctus*, the metatherian *Didelphis marsupialis* and the monotreme *Tachyglossus aculeatus* in 3D, to update on the known variability in extant mammals. Additionally, humeri from two stem-mammals, *Galesaurus planiceps* and *Morganucodon* sp.,

are included to infer the ancestral condition for Mammalia. Two types of canals are considered; piercing canals that pierce through the metaphysis and cartilage canals that are connected to the perichondrium. Cartilage canals are reported in *D. marsupialis*, where these were previously thought to be absent. Traces of cartilage canals are also found in *Morganucodon* sp. Both fossil taxa exhibit piercing canals, as in monotremes and eutherians, although the canals are more numerous in the fossils. The distribution of cartilage canals therefore is wider than previously assumed. This new fossil data shows that both types of canals have evolved within the mammalian stem-group, thereby suggesting that the process involving both types of canals for ossifying epiphyses is relatively ancient.

ID 170

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Distribution of the Species *Anancus arvernensis* (Croizet & Jobert, 1828) in Oltenia (SW of Romania)

Poster Presentation

This research documents the distribution of the mastodon *Anancus arvernensis* (Croizet & Jobert, 1828) on the territory of Oltenia, Romania. The region of Oltenia occupies the south-west of Romania and is framed by the river Olt (on the Eastern side), by the river Dunarea in the South and by the Meridional Carpathian arch in the North and West. Until now, two species of mastodons have been discovered in Oltenia: *Mammuth borsoni* and *Anancus arvernensis*. They have been discovered in various rock formations of either Pliocene or Pleistocene age. The presence of *Anancus arvernensis* is well documented on the territory of Oltenia. Beside the molars, there have been discovered parts of the postcranial skeleton (for instance femora, humerus, ribs belonging to the exemplar of *A. arvernensis* near Stoina, discovered in 1928 and described by C. S. Nicolaescu Plopsor in 1929). Only a small number of pieces belonging to this species have been described until now, and there are, in the warehouse of the Oltenia Museum (or in that of other institutions), several pieces which have never been studied. My intention is to shed light on all the occurrences of mastodons on the territory of Oltenia and to update the map of the distribution of this species. For Romania and for Oltenia in particular, *Anancus arvernensis* is important from the paleo-geographic, the paleo-ecological as well as from the stratigraphic point of view.

ID 190

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Climbing About, Flying Around: Effects of Precocial Forelimb Usage on the Bone Histology of Hoatzin and Its Implications for Forelimb Function in Bird-Like Dinosaurs

Oral Presentation

The juveniles of the enigmatic tropical bird, hoatzin (*Opisthocomus hoazin*), show an apparently ancestral feature throughout their ontogeny: they bear two pairs of claws on their mobile wing digits which enable them to climb in trees. When a predator approaches, the chicks drop into water below the nest, swim, and climb back to the vegetation using both wings and legs. Wing claws mostly disappear in adults when they start flying. Climbing trees requires strong, functionally developed forelimbs already early in ontogeny, and is expected to have a profound influence on, among others, the bone histological features of the wings. Hence, hoatzin limb bones representing different ontogenetic stages may inform about potential osteohistological correlates of this unusual precocial climbing behaviour as well as the functional shift in the forelimb from juvenile climbing to adult flight. Preliminary analysis of thin sections and μ CT scans of juvenile bones revealed a special growth mark in multiple elements recording a considerable disruption in diametric bone growth. These growth marks may be related to the onset of climbing, as such structures have not been reported in juvenile limb bones of other precocial birds (e.g. mallards). Analysing adults and other taxa with precocial hindlimb and altricial forelimb development are crucial to infer the extent to which such functional factors shape the osteohistological characteristics in the hoatzin and provides a basis for inferences on the evolution of grasping and/or flight-related forelimb functions in the dinosaur-bird transition; the focus of this project on the evolution of avian flight.

ID 105

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The Ecomorphological Affinities of the Miocene Platyrrhine Tali

*Oral Presentation, Student Contribution
Symposium: Ecomorphology and Functional Anatomy
in Vertebrate Palaeontology*

Platyrrhines are a diverse group of primates that presently occupy a broad range of tropical and equatorial environments in the Americas. However, most of the fossil platyrrhine species of the Early Miocene have been found in middle and high latitudes, which are areas that are nowadays uninhabited by non-human primates. One of the most commonly preserved anatomical structures of early platyrrhines is the talus, which is an ankle bone that is important to be studied because it has been suggested that its shape could reflect the function of the feet associated to postural adaptations, based on its central position in the foot as well as to its functional relations with other foot bones. Therefore, this work provides an analysis of the phenetic affinities of extant platyrrhine tali and their Miocene counterparts by using geometric morphometric (GM) and phylogenetic comparative analyses. GM was applied to quantify talar shape affinities, while comparative analyses were used to test different models that could explain talar shape and size evolution. Locomotor mode percentages (LMPs) were analyzed to test if talar shape is associated with locomotion and consequently used to infer locomotion. The present results show that most analyzed fossils exhibit a generalized morphology that is similar to some of the basal ancestral shape reconstructions and to some 'generalist' modern species. It was found that talar shape covaries with LMPs, thus allowing the inference of locomotion from talar morphology. Finally, the ancestral platyrrhine condition was reconstructed as a medium-sized generalized arboreal quadruped.

ID 202

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Recent Advances in the Comprehension of the Eocene Herpetofauna from the Geiseltal Lagerstätte (Sachsen-Anhalt, Germany)

Oral Presentation

The Middle Eocene Geiseltal locality near Halle (Saale) yielded exceptionally preserved articulated remains of amphibians, turtles, crocodilians, lizards and snakes. The taxonomy of many of these species needs modern revisions and a new international collaborative project has been recently established to undertake this task. Preliminary studies focused on the global phylogeny of softshell turtles and the alligatorine crocodylian *Allognathosuchus brevirostris*. The softshell turtle from Geiseltal is very similar to *Trionyx messelianus* from Messel. A comprehensive revision of previous morphological datasets of living and extinct pan-trionychids and the employment of a molecular backbone constraint shed new light on the body plan evolution of crown-softshell turtles. High levels of homoplasy are primarily responsible for poor phylogenetic resolution among extinct taxa. Moreover, equal character weighting resulted in a topology that is fundamentally inconsistent with molecular divergence date estimates of deeply nested extant species. In contrast, implied weighting retrieved Early Cretaceous fossil taxa as stem-trionychids, which is fully consistent with their stratigraphic occurrence and a previous molecular age estimate for crown-trionychids. These results indicate that the lack of peripheral elements (i.e. the condition in crown-trionychines) is primitive for softshell turtles and were subsequently reacquired in the cyclanorbine *Lissemys*. *Lissemys* therefore demonstrates a homologous reversal of dermal bone loss and provides a counterexample for Dollo's law of character evolution irreversibility. The Geiseltal alligatorine *Allognathosuchus brevirostris* is difficult to distinguish from *Hassiacosuchus haupti* from Messel and they may represent identical taxa. Current research aims to revisit the proposed hypothesis of multiple dispersals of alligatorines into Europe.

ID 209

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Evolution of Living and Fossil 'Protrogomorphous' Rodents

Oral Presentation, Student Contribution

The rodent genus *Ischyromys* was named in 1856 by Joseph Leidy, and is generally regarded as part of a grade that for over 20 million years dominated rodent faunas across Eurasia and North America: 'protrogomorphs', also including the late Paleocene-middle Eocene *Paramys*. The only extant 'protrogomorph' is the mountain beaver *Apodontia rufa*, which unlike other extant rodents possesses neither a large attachment site for the lateral masseter on its rostrum, nor an enlarged infraorbital foramen traversed by masticatory muscles. Here, we examine the craniosteal anatomy of fossil 'protrogomorphous' rodents, focusing on a previously undescribed, articulated skeleton of *Ischyromys* from the late Eocene of West Canyon Creek, Wyoming, using 3D reconstructions derived from microCT scans. Species of *Ischyromys* are variable in their rostral anatomy and include specimens that exhibit a large surface area, possibly for attachment of the lateral masseter, ventral and anterior to the maxillary root of the zygoma. *Ischyromys* differs from *Paramys* in showing relatively large infraorbital foramina, smaller than those seen among hystricomorph rodents but larger than those in *Apodontia* and sciurids. Whether or not it was anatomically protrogomorph, *Ischyromys* exhibits several anatomical features that are rare or absent among crown Rodentia, such as a masseteric fossa at or behind the level of m2, presence of an upper P3 in some species, and a robust fibula. *Ischyromys* and other fossil taxa thus help to understand the mosaic nature of character evolution among rodents.

ID 290

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A New Specimen of *Archaeopteryx*

Oral Presentation

The 'Urvogel' *Archaeopteryx* is certainly one of the most iconic fossils known, and even more than 150 years after its initial description, it remains a focus of ongoing research. Recently, a new specimen was discovered in the locality of Schamhaupten, Bavaria, in layers that are slightly older than the Altmühl Formation, and the new find thus represents the oldest known specimen of this taxon. The new specimen of *Archaeopteryx* shows for the first time the postorbital articulation with the jugal and thus confirms the presence

of a closed postorbital bar in this taxon. Other observations include the presence of opisthocoelous cervical vertebrae and a gastral basket that is preserved with its posterior end being placed at the mid-height of the pubic shafts. A survey of theropod specimens with preserved gastral baskets reveals that the latter seems to be the normal condition found in paravians, whereas in more basal taxa the gastral basket usually reaches the ventral end of the pubis; a possible explanation for this observation might be the presence of enlarged abdominal air sacs in paravian theropods, the post-mortem collapse of which draws the gastral basket dorsally. The new specimen differs from other specimens of *Archaeopteryx* in several details, including the shape and position of the promaxillary foramen, the development of the palate and the relatively short hindlimbs. However, more detailed studies of the variability within the available specimens of *Archaeopteryx* is necessary to decide whether this might be taxonomically significant or due to individual variation.

ID 311

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Comparative Anatomy of Soft-Tissue Organs Situated in the Rostral Region of Sauropterygia

Oral Presentation

The explosive diversification of early Sauropterygia during the Middle Triassic entailed a still poorly understood transition from semi-aquatic to obligate-aquatic forms, which renders them an excellent group to study secondarily marine vertebrate radiations and morphological adaptations to increasingly aquatic lifestyles. Typically involved are modifications of the sensory organs and the appearance of specialised osmoregulatory organs. We provide computer microtomography data with focus on the rostral region to compare the osteological correlates of three potential soft-tissue organs accommodated within the snout of sauropterygians. Selected crania of several nothosauroid and pistosauroid taxa were subjected to microtomographic scanning (μ CT and PPC-SR μ CT). Virtual endocasts of two independent structures were produced to visualise their respective endorostral aspects. They are here interpreted to have harboured narial salt glands and the vomeronasal organ during life. Facial salt glands are often associated with the narial passages, which seems to occur independently in vertebrates with a marine ecology. The vomeronasal organ of tetrapods is a paired rostral chemosensory device that opens into the buccal cavity through a specific

foramen and may be either functional, largely reduced or completely absent. Without concluding on its functionality itself, our data and the slight displacement as compared to extant diapsids suggest a highly adaptive and phylogenetic context. Thirdly, we present new evidence for a peripheral tactile system that appears more specialised in highly piscivorous taxa. The neurovascular system supported an integumentary sensory organ that shows similarities to the pressure receptor system of extant crocodylians, albeit with a different distribution of receptive fields.

ID 250

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The Oldest Fossil Record of *Gobius* (Teleostei, Gobiiformes)

Oral Presentation
European Fossil Fish Symposium

Gobiidae (Gobiiformes, Teleostei) is among the largest families of vertebrates. These fishes are distributed worldwide and contribute significantly to species diversity in marine habitats and reefs. However, their fossil record is sparse prior to the Miocene. Findings of isolated otoliths indicate that Gobiidae were present in the Late Oligocene and Early Miocene of Europe, but species diversity remained low. Articulated skeletons of *Gobius jarosi* Přikryl & Reichenbacher, 2017 from the Early Miocene of Central Europe (Moravia, Czech Republic) now confirm the otolith information. This species has been found in a marine setting. Calcareous nannoplankton from the holotype matrix revealed that its age is 19.1–20.4 Ma. Thus *G. jarosi* is the currently oldest known representative of the modern genus *Gobius* that is based on articulated skeletal material. *Gobius jarosi* displays a pterygiophore formula of 3-22110, 11+16–17 vertebrae, six thin spines in the first dorsal fin, one spine and 12 rays in the second dorsal fin, and one spine and 11 rays in the anal fin. Its osteological and meristic characters are most similar to the extant species *Gobius niger* Linnaeus, 1758, *G. roulei* de Buen, 1928 and *G. vittatus* Vinciguerra, 1883.

Accompanying fish fossils and nannoplankton assemblages indicate that *G. jarosi*, like the extant species *G. roulei* and *G. vittatus*, lived in an inshore to offshore ecosystem. The discovery of this oldest member of the lineage leading to the present-day species of *Gobius* indicates that diversification of the European Gobiidae began in, but not before, the early Miocene.

ID 130

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New Insights into the Phylogenetic Relationships and Biogeography of Madtsoiid Snakes from a Revision of *Gigantophis garstini* from the Upper Eocene of North Africa

Oral Presentation

Madtsoiidae is a speciose family of extinct snakes that achieved a wide Gondwanan and trans-Tethyan distribution by the Late Cretaceous, surviving until the late Pleistocene. *Gigantophis garstini*, the first and largest described madtsoiid, was recovered from the upper Eocene of Fayum, Egypt. The twenty vertebrae that comprise the syntype have only received a brief description, hindering the referral of specimens to this taxon and our understanding of madtsoiid interrelationships. A detailed re-description of the syntype material demonstrates the validity of *Gigantophis*, based on two autapomorphies (including a strongly depressed neural canal in posterior trunk vertebrae) and a unique combination of characters. Referred material from the lower Paleocene of Pakistan differs significantly, and we restrict *Gigantophis* to the middle–late Eocene of North Africa. Using a model of morphological variation in extant snakes, we estimate that *Gigantophis* was 6.9 ± 0.3 m long. A phylogenetic analysis using the largest sample of putative madtsoiids (20 OTUs) and a revised and augmented matrix (148 characters), places *Gigantophis* as sister taxon to the latest Cretaceous Indian snake *Madtsoia pisdurensis*. Whereas our topology might suggest that a dispersal route was present between India and North Africa in the latest Cretaceous–early Paleogene, an evaluation of putative dispersal routes leads us to conclude that the paleobiogeography of Madtsoiidae is best explained by a poorly sampled, earlier widespread distribution in Africa, Indo-Madagascar and South America. In contrast, latest Cretaceous madtsoiid occurrences in Europe might be explicable by trans-Tethyan dispersal from Africa across the Apulian Route.

ID 285

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A New Plesiosaurian from the Slottsmøya Member (Volgian) of Central Spitsbergen and Its Implications for Cryptoclidid Phylogenetic Relationships

Oral Presentation, Student Contribution

The Slottsmøya Member from central Spitsbergen is a rich marine reptile Lagerstätte, spanning the Jurassic – Cretaceous boundary and is abundant in ophthalmosaurid ichthyosaur, pliosaurid and cryptoclidid plesiosaur specimens. Here we present the osteology and phylogenetic placement of a new taxon of plesiosaur, representing the fifth and youngest cryptoclidid taxon described from the member. This specimen (PMO 224.248) derives from a section encompassing the latest Tithonian – earliest Berriasian (late Volgian) and is likely Early Cretaceous in age. PMO 224.248 is unique from the Slottsmøya Member in preserving a cranium, partial mandible, complete and articulated cervical, pectoral and anterior-dorsal vertebral series, pectoral girdle and forelimb material. For the first time, detailed cranial anatomy of a cryptoclidid plesiosaur is described using computed tomography. New external and internal cranial features include an interfrontal vacuity, parietal fossae and the configuration of the palate. These features are also confirmed in some cryptoclidid taxa and may represent unique cryptoclidid characteristics. The cervical series (50 vertebrae) of PMO 224.248, displays conspicuous disparity in the proportions of the centra and morphology of the neural arches throughout the series. This variation is compared with other penecontemporaneous taxa and may have implications for inferring neck-flexibility in cryptoclidid plesiosaurs. Using phylogenetic characters from original and published work, phylogenetic analysis including PMO 224.248 presented a new tree topology for the intrarelationships of Cryptoclididae. These results show that at least two cryptoclidid lineages were present in the Boreal Realm during the Late Jurassic – Early Cretaceous interval.

ID 114

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Variability and Potential Shifts in Body Masses of Small Cervids and Bovids From the Pleistocene of Java

Poster Presentation

Evolutionary shifts in body size exhibited by island biotas result from the synergetic influences of selective biotic and abiotic forces. Inquiring into the nature and rate of these trends in the light of the island rule is helpful to better understand changes in the structure of insular communities over time. Java, one of Greater Sunda Islands, is characterised by a complex palaeogeographic history and fossil record and deciphering the structure of its mammalian palaeocommunities during the Pleistocene is a difficult task. The aim of this study is to investigate the potential shifts in body masses of *Duboisia santeng* - a boselaphine bovid - and two cervid species - *Axis lydekkeri* and *Cervus kendengensis* - from the Early and Middle Pleistocene of Java.

We reconstructed body masses of the focal species and we investigated the spatial and temporal variability of our dataset between different local faunal assemblages and faunal units (Trinil HK and Kedung Brubus). Moreover, we discussed the role of sexual dimorphism, inter- and intra-guild dynamics, and taphonomic and taxonomic biases in driving the observed body mass shifts. All in all, results obtained proved to be useful in supporting the ecological hypothesis for body size evolution on islands, which predicts that the magnitude and direction of body size evolution and the underlying selection forces should be contextual to the size and trophic strategies of both the focal species and those species with which they interact.

ID 258

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Pliosauromorph Plesiosaurian Remains from the Late Cretaceous of Northwestern Germany

Poster Presentation

Plesiosaurian skeletal remains are rare in Late Cretaceous strata of Europe. During several years in the 1950's, various cranial and postcranial elements of a pliosauromorph plesiosaurian had been collected by amateurs at Anröchte, North Rhine-Westphalia, northwestern Germany. They were donated to the Geomuseum of the WWU, Münster, but remained unstudied over decades: their softness combined with the embedment in a hard siliceous rock precluded preparation until suitable techniques were developed. These remains represent the most complete plesiosaurian reptile find from Turonian strata in Europe, but they have only been studied provisionally as yet. The material comes from the Soest Greensand Member (Salder Formation) of Late Turonian age. Included are elements of the skull and lower jaw, isolated teeth, vertebrae, a scapula, an ilium and limb elements. The teeth are robust and conical, bearing prominent enamel ridges on the surface of the crown. The cervicals are amphicoelous. Characteristics at the propodials include a facet for a supernumerary epipodial at the humerus and femur as well as a massive, dome-shaped capitulum at the femur. The robust, conical teeth and the massive rostrum demonstrate that the Anröchte plesiosaurian was a pliosauromorph and an apex predator in its environment.

ID 216

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Phylogenetic Position of the Ornithomimosaur *Kinnareemimus khonkaenensis* from the Early Cretaceous of Thailand

Poster Presentation, Student Contribution

In 1995, remains of a few individuals of a small ornithomimosaur were reported from the Early Cretaceous Sao Khua Formation of north-eastern Thailand. The material was named *Kinnareemimus khonkaenensis* in 2009. It remains the only report of this group in Southeast Asia. *Kinnareemimus* was concluded to be a member of *Ornithomimosauria* more derived than *Harpymimus* and *Garudimimus* but more basal than *Archaeornithomimus*. However, *Kinnareemimus* was never included in a cladistic analysis. The preliminary results of a phylogenetic analysis using TNT of the relationships of *Kinnareemimus* (104 taxa, 568 characters) suggest it might be a basal ornithomimosaur. The tree topology agreed with previous analyses, for example, in a clade Deinocheiridae, consisting of *Deinocheirus*, *Garudimimus*, and *Harpymimus* which share some characters such as the

rectangular cross section of metatarsal III. *Kinnareemimus* looks similar to *Garudimimus* in the shape of the fibula in proximal view. The *Kinnareemimus* metatarsal III shows a subarctometatarsalian condition which might have evolved independently from other ornithomimids. However, the basal position of *Kinnareemimus* could also be due to immaturity and incompleteness of the material. This study shows that the evolution of the arctometatarsalian condition in ornithomimosaurs was not a simple, linear process. Apparently, the basal ornithomimosaurs were more widespread during the Early Cretaceous than in the Late Cretaceous, when they were restricted to Central Asia and North America. *Kinnareemimus* being one of the oldest and most basal ornithomimosaurs indicates that Southeast Asia played an important role in the early radiation of the Ornithomimosauria.

ID 131

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Who is Who? Comparative Morphology of the Miocene Eurasian Musk-Deer *Micromeryx* and *Hispanomeryx* (Mammalia, Ruminantia, Moschidae)

Poster Presentation

Moschids (musk-deer) are a group of ruminants defined as the least inclusive clade of crown-pecorans containing *Hispanomeryx* and *Moschus*. The earliest fossil record of musk-deer dates from the middle Miocene (MN4), although they probably appeared earlier. During the middle-late Miocene moschids became an ubiquitous component of Eurasian mammalian continental faunas, with two widely recognized genera that were distributed from the Iberian Peninsula to Mongolia: *Micromeryx* and *Hispanomeryx*. Moschids went extinct in Europe during the Turolian, but continued existing in Asia where they persist today (*Moschus* spp.). In Europe *Micromeryx* is a better-known taxon than *Hispanomeryx*, due to: a) *Micromeryx* was described in 1851, *Hispanomeryx* much more recently in 1981; b) until recently there were no cranial and postcranial fossils of *Hispanomeryx* described for comparison. The bulk of European *Hispanomeryx* fossils (and all described European species) come from Spain, where it appears in several sites ranging from MN6 to MN11. *Micromeryx* on the other hand is widely known across middle-upper Miocene European sites. Clearly, *Hispanomeryx* continues to be misidentified in Europe. We used the exceptional fossil record of Spanish Miocene moschids to map the anatomy of both *Micromeryx* and *Hispanomeryx*. Hence, we provide here a list of anatomical differential traits (cranial, mandibular, dental and postcranial) that can be used to separate apart both genera. We describe these features as a sort of a 'field guide' that can be used on moschid collections with the purpose of

doing accurate identifications and start knowing the true distribution of *Hispanomeryx* in Europe.

ID 282

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Testing Adaptive Radiation Scenarios in Marine Fishes by Combining Phylogenomic and Paleobiological Data

*Oral Presentation
European Fossil Fish Symposium*

Adaptive radiation scenarios have been invoked to explain the diversity of some of the best studied groups of organisms (e.g., Rift lake cichlids, Hawaiian Silversword Alliance, passerine birds). Under the most traditional adaptive radiation model numerous lineages start diverging within a brief period of time from an ancestral adaptive type, with each new lineage filling an available ecological niche; subsequently this rapid initial morphological evolution is replaced by relative stasis due to most available niches having already been filled. A number of recent studies, based on molecular phylogenies, questioned the generality of this model and found little evidence of an early burst of morphological diversification in most studies. For most of these clades, however, it is not known if inclusion of the paleodiversity would have modified the results. I will compare the results of our study of several major groups of marine teleosts, such as tetraodontiforms (puffers, triggerfishes and allies), carangoids (jacks, remoras), acanthuroids (surgeonfishes, luvar) and sparoids (seabreams, emperors and allies). All of these groups possess a rich fossil record - mostly known from European sites - which to date has rarely been used in evolutionary studies. I will show how the results based on extant taxa and those based on extant plus extinct species differ, and how inclusion of fossil data can alter the conclusion of studies based on molecular phylogenies.

ID 169

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Leopard as Taphonomic Agent in Southwestern Europe

Poster Presentation

Bone accumulations created by carnivores during the Pleistocene have been largely associated with the action of cave hyenas (*Crocota spelaea*), which transported their prey to inside cavities all over Europe. Yet in recent years it has been shown that leopards (*Panthera pardus*) played a role in the creation of bone accumulations in Southwestern Europe. Although the presence of this carnivore in Europe during the Pleistocene was well known, its ability to create bone accumulations was hardly considered. In this study we present three different cases of bone accumulations created by the action of leopards: Los Rincones, Racó del Duc and S'Espasa. All these sites are present in mountainous areas and with a probable age of Late Pleistocene. In these sites the main taxon is the Iberian wild goat (*Capra pyrenaica*), and the main carnivore is the leopard. In this work we have summarised the main taphonomic characteristics of the sites accumulated by leopards. The predator-prey relationship has also been analysed in different sites of Southwestern Europe and it has been shown that leopard was specialised in catching goats, showing similar behaviour to that of extant snow leopards (*Uncia uncia*). Said specialisation may have been due to the occupation of caves in steep areas where rupicolous fauna predominated.

ID 117

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The Lacrimal Bone Diversity in Cervidae - What Size and Shape Tell Us about Cervid Evolution

*Oral Presentation, Student Contribution
Symposium: Ecomorphology and Functional Anatomy
in Vertebrate Palaeontology*

Most mammals possess a lacrimal bone, which builds the rostral rim of the orbita. In deer (Cervidae, Artiodactyla), the bone acquires considerable size compared with other mammals. It is characterized by a depression hosting the lacrimal gland, whose secretion is used for territory marking. The lacrimal bone and its depression are very variable in both size and shape within cervids being useful for systematics. However, the underlying causes for this variability remain so far unexplained. Given the central position of the lacrimal bone in the facial skull (it articulates with the nasal, frontal, sphenoid, jugal, and maxilla), it is likely that the bone reflects adaptations to different ecological niches and different behaviours. This hypothesis coincides with the evolution of cervids, where early small forest dwellers from tropical

/subtropical habitats grew in size and adapted to temperate and subarctic regions. In our presentation, we give an overview of size and shape in some living cervid species and the correlation with behaviour and habitat. We use the results to infer on behaviour and ecology in fossil cervids.

ID 204

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Age and Origin of Afro-European Gobies (Teleostei: Gobiidae)

Oral Presentation

European Fossil Fish Symposium

With more than 1800 described species the teleost fish family Gobiidae is the second most species rich fish family globally. Approximately 200 species are distributed in the temperate and eastern Atlantic, the Mediterranean Sea, in Ponto-Caspian fresh and brackish waters and along the Southern African Cape. We present the first comprehensive molecular phylogenetic hypothesis for these Afro-European gobies belonging to the three previously established *Gobius*-, *Pomatoschistus*- and *Aphia*-lineages sensu Agorreta et al. (2013). The analysis is based on approx. 5000 bp of nuclear and mitochondrial markers. The taxon sampling contains members of all genera of these lineages as well as a global outgroup sample. Fossil calibration is applied conservatively with three carefully selected fossils plus one secondary root calibration and includes alternative placements of fossils accounting for phylogenetic uncertainty. The *Gobius*-lineage includes the Southern African genus *Caffrogobius* and the Western Indian Ocean genus *Coryogalops*. Sister taxa of all three lineages turn out to be of Indo-Pacific origin. A biogeographic analysis tests alternative hypotheses about immigration pathways from the Indo-Pacific to the Atlantic, Mediterranean and Ponto-Caspis.

ID 288

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The Evolutionary Significance of Phosphatic Otoliths in Cartilaginous Fishes (Chondrichthyes, Elasmobranchii)

Poster Presentation

Dense bodies made of calcareous crystals are found in the skeletal inner ear labyrinths of living and extinct vertebrates and vary regarding both the material composition and the morphology. While large, solitary structures termed otoliths have long been known and analysed in bony fishes, the significance, and functions of such structures are widely neglected in cartilaginous fishes. Holocephalans (chimaeras) and elasmobranchs (sharks, rays and skates) are considered to develop single crystalline structures made of different calcium carbonate polymorphs as well as to incorporate exogenous material in their inner ears via the endolymphatic duct. In the present study, we investigated the morphology and composition of these structures in two extant rays and their distribution in 35 extant chondrichthyan specimens. Dissections, micro-CT scanning, and 3D reconstructions were used to examine the presence, shape, and positioning of the structures within the skeletal labyrinth. Infrared spectroscopy analysis provided information on the chemical composition. Contrary to earlier findings, these rays form solid, solitary apatite aggregates within their skeletal labyrinths. Elasmobranch otoliths can be differentiated by a specific morphology similar to the lagena, utricle, and lapillus in bony fishes and are clearly identifiable in micro-CT scans. According to our results, phosphatic otoliths are plesiomorphic for vertebrates occurring in both agnathans and chondrichthyans and the presence of calcium carbonate otoliths in bony fishes thus are derived features. The presence of otoliths in ostracoderms and placoderms as well as the underlying reasons for the shift from phosphatic to carbonatic otoliths within gnathostomes, however, remain elusive momentarily.

ID 122

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First Visualization of the In-Situ Motion of Otoliths in the Fish Ear

Oral Presentation

Regarding the basics of ear structure-function relationships in fishes, the actual motion of the solid 'ear stone' (= otolith) relative to the underlying sensory epithelium has rarely been investigated. Until now, the characterization of otolith motion has been based on few experimental studies and on approaches using mathematical modeling. These studies yielded conflicting results in either predicting a simple back and forth motion of the otolith relative to the underlying sensory epithelium or a shape-dependent, complex otolith motion. Our study thus aims to provide experimental data to test previous models and predictions of otolith motion. As this investigation of basic parameters of otolith motion requires an approach with high spatial and temporal resolution, we used hard X-ray phase contrast imaging (XPCI) at the European Synchrotron Radiation Facility (Grenoble). We compared two anatomically well studied cichlid species that differed in the 3D shape of their otoliths and swimbladder size. *Steatocranus tinanti* has elongate otoliths and a vestigial swimbladder whereas *Etilia maculatus* displays oval otoliths and possesses a large swimbladder contacting the ears. In a tank filled with water, we presented a pure tone of 200 Hz to i) a single otolith embedded in 1% Agarose or ii) a fresh dead fish both in dorsal and lateral orientation. Our study is the first that successfully visualizes the motion of otoliths in-situ and seem to provide support for the shape-dependent model of otolith motion. A better understanding of how otolith shape affects ear physiology may also allow a physiological interpretation of fossil otoliths.

ID 297

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Dogs - Lifestyle Change from Arboreal to Terrestrial: 3D Reconstruction of the Bony Labyrinth

Oral Presentation, Student Contribution

Symposium: Ecomorphology and Functional Anatomy
in Vertebrate Palaeontology

Extant Canidae are known to have essentially a terrestrial mode of locomotion and occur in nearly all habitats and continents. The family Canidae originated approximately 40 Million years ago with the first dog, *Hesperocyon*, which differs completely from the extant canids in its small size and arboreal lifestyle. The bony labyrinth can be preserved very well in the fossil record as it is surrounded by the petrosal bone, which is one of the densest and hardest bones in the mammalian body. The inner ear consists of two main parts, the vestibular system for perception of balance and the cochlea for sound detection. In the vestibular system three semicircular canals are orientated approximately perpendicular to one another for detection of angular acceleration. Therefore the bony labyrinth can be used to reconstruct locomotion modes and habits of extinct canids. Bony labyrinths of 20 extant and extinct canid specimens were scanned non-invasively with a CT device and reconstructed three - dimensionally for investigation of a functional morphological signal. Measurements were taken directly on the segmented 3D labyrinths and standardized to have size independent values. For comparison of the different locomotion habits a principal component analysis has been calculated to define delimitable morphospaces with some overlapping regions. These morphospaces convey information about morphology of the bony labyrinth for adaption in locomotion in the family of the Canidae. In connection with the shape of the semicircular canals the locomotion mode in context with ecological factors can be shown and interpreted in a phylogenetic context.

ID 165

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A New Cretaceous Ichthyosaur Rostrum from the Northern Apennines (Italy) Investigated with CT Scan Technology for Morphological Analysis

Poster Presentation

In 2015 a fragmentary ichthyosaur rostrum, 251372, was found near Gombola (Modena Province) in the northern Apennines. It comes from the Rio Cargnone Formation, dated to the late Paleocene-Lutetian but containing mainly material reworked from older formations, among which the Argille a

Palombini Fm. (Lower Cretaceous-Turonian) or the Argille Varicolori di Cassio Fm. (Cenomanian-lower Campanian), both deposited in deep-sea settings, are possible sources for the rostrum. The matrix of 251372 does not contain microfossils, therefore we could not determine its precise age. The preliminary study, made on the fossil still partially embedded in the matrix, used a CT scan to obtain a 3D model and to identify the premaxilla and dentary; the fragment was positioned close to the tip of the rostrum. We counted 34 conical teeth with large quadrangular roots. The latter feature allowed us to refer the specimen to the subfamily Platypterygiinae. The fossil displays a deep fracture on the distal extremity, where teeth are broken and bent; this crack is infilled by matrix, suggesting the break occurred prior to the burial. It could be due to scavenging activity, as suggested also by a small shark tooth preserved on the proximal side of the fossil. The rostrum 251372 shows some similarities with another ichthyosaur rostrum from the same locality (IPUM 30139), discovered in 1889 and previously identified as *Platypterygius* sp. The two fragments share similar lateral compression, with the displacement of the premaxillae, suggesting that they could possibly belong to the same specimen.

ID 238

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Heterochronic Changes in the Cranial Geometry of *Saurolophini* (Hadrosauridae: Dinosauria)

Poster Presentation, Student Contribution

Variation in the crest shape among lambeosaurine hadrosaurs is well known; however, it has been poorly studied in terms of heterochrony. The study deals with timing of developmental changes in the skull size and structure in *Saurolophinae*, a sister clade to *Lambeosaurinae*. Geometric morphometrics was employed to quantify shape in twenty three skulls of some *saurolophine* hadrosaurs (namely: *Saurolophini*), including *Saurolophus angustirostris*, *S. osborni*, *Prosaurolophus maximus*, *Edmontosaurus regalis*, and *E. annectens*. The last three species do not exhibit noticeable heterochrony. Their specimens cluster together and there is a tendency to flattening the skull with age. *Edmontosaurus* clusters overlap each other due to overall similarity in shape. However, canonical variate analysis (CVA) clearly separates two studied species of *Edmontosaurus*. The skull geometry of *Saurolophus* changes during ontogeny in a different way. Juveniles of *S. angustirostris* are more similar to *S. osborni*, whose adults gain longer, but also higher skulls, while the skulls of adult *S. angustirostris* become longer and flatter. CVA does not separate two species of *Saurolophus*, and regression score plotted against the centroid size shows clear

association between size and shape. Because of similar age (early Maastrichtian) of both *Saurolophus* species, it is hard to determine, which of them is the ancestral species. Thus, it can be suggested that the evolution of these two taxa was either hypermorphotic (if *S. osborni* was ancestral) or progenetic, if *S. angustirostris* was the ancestor.

ID 302

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Implementing Cranial Kinesis of Accipitridae in a Finite Element Model of the Skull

Poster Presentation, Student Contribution

Finite Element Analysis (FEA) is gaining popularity in paleontological studies. Skulls often are considered as one solid block of bony material, leaving out detail in form of flexibility. While cranial kinesis plays an important role in feeding, no FEA studies have included it in a model. This study aims to include cranial kinesis in a FEA model and thereby showing the importance of cranial kinesis in future FEA studies. Accipitridae display prokinesis; a single flexible zone in front of the nasal and thereby the simplest form of cranial kinesis known in birds. Measurements of the kinetic zone were taken directly on the skull for 12 different species within the Accipitridae. Flexibility was measured as the angle the upper jaw could move relative to the cranium. The width and thickness of the kinetic zone were measured as parameters for flexibility. The skull of *Gypaetus barbatus*, as a case study, was μ CT-scanned. This skull was modeled by importing CT-data into Amira and Strand 7. When analyzed, the flexibility in these bird skulls show a predominant correlation with the width of the kinetic zone. By varying Young's modulus in the kinetic zone of the model the measurements are mimicked. These results can also be used in future studies, such as in the analysis of the extinct Haast's eagle (*Harpagornis moorei*).

ID 148

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Redescription of a Uniquely Three-Dimensionally Preserved *Tanystropheus longobardicus* Specimen from the Grenzbitumenzone of Monte San Giorgio, Switzerland

Poster Presentation

The extremely elongated neck and lack of evident adaptations for aquatic locomotion make the archosauromorph *Tanystropheus longobardicus* into possibly the most bizarre and controversial Triassic reptile. Although its palaeobiology and functional morphology have received much attention, a consensus has yet to be reached. Furthermore, as the best known member of Tanystropheidae, an understanding of *T. longobardicus* morphology is also of importance for phylogenetic considerations. Several articulated specimens are known from Switzerland, Italy, and China. Typically *Tanystropheus* fossils are strongly compressed and have a plate-like preservation. Here we present the redescription of a uniquely three-dimensionally preserved specimen of *T. longobardicus* of approximately 1.40 metres long, which has only been briefly described previously by Rupert Wild in 1980, some years after his main monograph on *T. longobardicus*. The three-dimensional preservation of the vertebrae allows for a new interpretation of the morphology of the posteriormost cervical and anteriormost dorsal vertebrae. The 12th and in particular the 13th presacral vertebra show a transitional morphology between the typical cervical and dorsal vertebral morphology in rib attachments and vertebral length. These observations of the base of the neck further illustrate the unique architecture of *Tanystropheus* neck and could potentially provide new insights into neck posture. However, because of the transitional morphology of these vertebrae, we refrain from stating an unequivocal cervical number for *T. longobardicus*, which had 12 or 13 cervical vertebrae. Additionally, we corroborate Renesto's observation that the tail of *T. longobardicus* was very wide proximally and poorly adapted for aquatic propulsion through lateral undulation.

ID 221

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Histology and Growth of *Iguanodon bernissartensis*

Oral Presentation

The Bernissart iguanodonts represent the largest find of complete skeletons in Europe. Recent research demonstrated morphological variation in *Iguanodon bernissartensis*, but no data on the ontogeny of the individuals was included. Here we present the first results on the histology growth and preservation of *Iguanodon bernissartensis* from Bernissart (Belgium) and the contemporary bonebed locality of Nehden (Germany), from which hundreds of disarticulated bones of *I. bernissartensis* of similar preservation were uncovered. Our analytical approach (polarized light microscopy, μ XRF,

FTIR spectroscopy, carbon and oxygen stable isotope analysis) demonstrates the morphological preservation of bony tissues, and presence of metal sulfides and silicates in the medullary cavity. Pyrite has thus not penetrated the bony tissues themselves, which allowed assessment of the growth of this iconic taxon. In addition, the pyrite also protected the bone periphery from erosion, so that the highly porous outermost rim of freshly grown bone tissue is still preserved in some specimens. The long bone tissues generally show a fast growing woven-parallel fibered complex with numerous longitudinal to circumferential primary osteons arranged in a laminar to plexiform pattern, similar to other iguanodontians and hadrosaurs. We found very few growth marks (3 to 4 in the ribs of large specimen RBINS I52, and up to 5 in femur WMN P61446 (80/436) from Nehden), which occur as vascularization shifts, annuli, and/or LAGs. The abundance of erosion rooms is less pronounced than in hadrosaurs, but *Iguanodon bernissartensis* likely grew similarly fast to the more derived hadrosaurs.

ID 227

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The Pycnodont Fish *Nursallia gutturosus* in the Late Cretaceous (Early Turonian) Marine Ecosystem of Vallecillo, NE Mexico

Poster Presentation, Student Contribution

Pycnodont fishes are documented from the Late Triassic to the Eocene and were distributed widely from the Americas to Europe and Africa. They were generally deep-bodied, laterally compressed and durophagous. They were considered to be good maneuverers that lived in shallow reefs or lagoonal ecosystems feeding on hard-shelled prey. The pycnodontid *Nursallia gutturosus* from the marine platy limestone deposit of Vallecillo, 100 km north of Monterrey, Mexico, is well documented. Fossils from this Plattenkalk deposit are dated to the latest Cenomanian and early Turonian. They show excellent preservation of soft tissue, due to anoxic sea floor conditions and the absence of currents near the bottom. Inoceramids are the only benthic organisms known to this date. The Vallecillo platy limestone represents a pelagic habitat with a mixture of faunal elements of both Western Interior Seaway and Tethyan origin, as well as taxa endemic to the Gulf of Mexico. *Nursallia gutturosus* populated the open water, which opposes the interpretation of this pycnodontid as a coastal fish. Even though dentition is characteristically pycnodontid, with a small mouth opening, no hard-shelled prey is presently found. The deep-bodied shape and small pectoral fins clarify the picture of a slow swimmer. Our investigation on *Nursallia gutturosus* is based on 90 individuals ranging from 70 mm to about 610 mm

body length, allowing the identification of sexual dimorphism. In addition size and distribution show that the taxon was indigenous to this habitat. Thus *Nursallia gutturosum* takes an exceptional role in the marine ecosystem of Vallecillo.

ID 249

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The Mexican Fossil Ground Sloths, a Case Study for Late Pleistocene Palaeogeographic Distribution in the Mexican Corridor

Oral Presentation, Student Contribution

Ground sloths were enigmatic tetrapods that were characteristic and exclusive of the New World. They had their major distribution during the Neogene, especially during the Pleistocene. The dispersion of ground sloths across the American continent in some regimes resulted in the evolution of endemic forms apparently with specific habitat preferences. In contrast to the extensive fossil record from the Caribbean, North- and South America, only a few and majorly fragmentary remains have been reported from Central America. Even these occurrences are frequently ignored in the scientific literature, despite the importance of the Mexican palaeobiogeographic corridor for an evaluation of evolutionary relationships between the North- and South American mammal megafaunas, their faunal dispersion and geographic exchange. Our initial investigation on Mexican ground sloths shows already that the present database dating as far back as 2002 is out-ranged by numerous new discoveries, and that there is an apparent information deficit on Mexico. We therefore propose to document and revise the distribution pattern of ground sloth species in Mexico and Central America and to reconstruct their environment based on the pollen record and co-existing megafaunal assemblages. This pilot project could be a case for further studies on the palaeobiogeographical importance of Central America as a bridge between the two subcontinents as well as the pattern of megafaunal extinction (e.g. regional refugia) in the Pleistocene-Holocene transition.

ID 220

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Phylogenomics of Evolutionary Old Clupeocephalan lineages and a Critical Discussion of Morphological Apomorphies

*Oral Presentation
European Fossil Fish Symposium*

Previous molecular studies on the phylogeny of clupeocephalan fishes revealed numerous new taxonomic entities. For re-analysing these taxa on a phylogenomic scale, we perform target gene capturing for putative ortholog exons of major lineages of clupeocephalan fish species on ordinal level. Sequence information for the RNA bait design was derived from publicly available genomes of bony fishes. Newly acquired sequence data comprising more than 1000 exons was subsequently used for a phylogenetic reconstruction. Preliminary results verify the monophyletic Otomorpha with Alepocephaliformes sister to Ostariophysi, with Clupeiformes as basal taxon. Euteleosts form four major clades. Lepidogalaxiiformes appear as sister to all remaining euteleosts. The three remaining euteleost lineages are formed by a clade comprising Argentini-, Esoci- and Salmoniformes (Protacanthopterygii) and its sister clade including the Stomiati (Osmeriformes and Stomiatiiformes). The neoteleost clade appears as sister to all of the aforementioned taxa. Neoteleost lineages included in our study include Aulopiiformes sister to a clade containing Ateeopodiformes and *Trachypterus* representing Lampridiformes. Molecular phylogenies including the tree reconstruction presented herein have called numerous morphological apomorphies of clades into question, as topologies derived from morphology and molecular data differ significantly. We critically discuss these apomorphies, reviewing their validity.

ID 160

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New Data on the Middle Triassic Vertebrate Locality in Miedary (Southern Poland)

Poster Presentation

Since 2013, fieldwork proceeds in the new Middle Triassic, vertebrate-yielding locality in Miedary, Silesia (Southern Poland). Palynological data as well as the local geology indicate a Ladinian age of bone-bearing deposits. Previously, we reported the occurrence of shark teeth, ganoid fish scales, a mastodonsaurid mandible, nothosaurid and tanystropheid vertebrae, and teeth of rauisuchians. Since then, we have organized two month-long excavation camps with European students. During these two seasons of intensive excavations, we have collected a lot of new materials. Reptilian ribs and three-dimensionally preserved vertebrae dominate the site and the very elongated cervical vertebrae of *Tanystropheus* are most characteristic among them. We also collected two new mandibles of a mastodonsaurid and many of its teeth. In 2016, we found a very large scapulocoracoid, probably belonging to this taxon as well. Totally new is an extremely large tooth plate of a dipnoan fish. This specimen represents one of only few known Ladinian dipnoans in the world. Another novelty are the remains of Plagiosauridae (e.g., a clavicle). As evidenced by the taxonomic composition, Miedary is mainly an aquatic assemblage. The locality is very rich in specimens, competing only with the Carnian Krasiejów lagerstätte for the title of the most abundant vertebrate-yielding outcrop in Poland.

ID 159

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Evidence of Tuberculosis-Like Infection in a Middle Triassic Eusauroptrygian, *Proneusticosaurus silesiacus* Volz, 1902

Poster Presentation

Pathological conditions occasionally observed in fossil

skeletal remains provide an opportunity for epidemiologic studies in prehistoric vertebrates. Such observations, although sporadic, are extremely significant in evolutionary studies, because diseases comprise very important selection factors for species survival. *Proneusticosaurus silesiacus* is a partially-preserved eusauroptrygian skeleton, described at the beginning of the 20th century from Gogolin quarry (Opole Silesia, Poland). Its detailed phylogenetic position within Eusauroptrygia is not established, but traditionally it is considered a postcranium of *Cymatosaurus*, a genus known so far only from cranial remains. Our detailed studies on re-assessment of *Proneusticosaurus* resulted in recognition of multiple superficial protrusions on the visceral surfaces of several neighbouring dorsal ribs. This kind of abnormal bone involvement is a result of continuous solid periosteal reaction and represents the earliest evidence for tuberculosis-like infection. We documented its infectious aetiology by X-ray microcomputed tomography (XMT) and histological examination of the pathologically altered rib. The result of our approach reveals a chronic, multi-seasonal disease affecting the bone tissue, which can be correlated with tuberculosis in recent vertebrates. However, this documentation carries additional important implications, because it substantially improves our state of knowledge about the history of pathogenic taxa. Furthermore, our case study may be useful to global epidemiologic studies, supplementing understanding of the evolution of trans-phylogenetic pathogenic taxa and their dispersals in timespans unattainable in contemporary studies.

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ID 197

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On The Reproducibility and Predictability of Dental Microwear Analysis in Ungulates

Oral Presentation

In theory, it is possible to gather information on the vegetation and climate of an era by studying the diet of extinct animals influenced by environmental factors. One of the possibilities to receive information is dental microwear analysis, which is widely utilised despite the many unanswered questions surrounding it. The focus of this study was the reproducibility of the method, and predictability of microwear patterns. Is it possible for two observers to repro-

duce the same microwear results? Is it possible to predict the hypothetical wear pattern on the surface of the upper and lower second molars based on the observed wear pattern of other molars and premolars? The samples used were the complete dentil of eight specimens from three extant ungulate species (*Capra caucasica*, *Caperolus capreolus*, *Cervus elaphus*). The methods utilized are standard for the microwear method: after cleaning the surface of the teeth high resolution epoxy casts were made from them. The number of scratches and pits were calculated on 0.4×0.4 mm areas on each cast by the two authors. The reproducibility was tested with the use of intraclass correlation coefficient and the predictability was tested with mixed models, where specimens were chosen as random factors and the position of the tooth was chosen as a fix factor. Our results suggest that reproducibility of the microwear results is high, and it is possible to predict the wear pattern of upper and lower second molars, thus the diet of an animal based on other molars and premolars.

ID 155

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Homeotic Shift at the Dawn of the Turtle Evolution

Oral Presentation, Student Contribution

Turtles possess one of the most specialized axial skeletons among vertebrates. Since the latest Triassic their presacral vertebral column is composed of only 18 (eight cervical and ten dorsal) elements. For nearly three decades, it was universally assumed that such a specialization is plesiomorphic for turtles and most likely inherited from their ancestors. New data reveal, however, that this axial formula became stabilized during the first several million years after the acquisition of the shell. Proterochersidae, the oldest and basalmost true turtles (Testudinata) from the Late Triassic (Norian) of Poland and Germany still had eleven dorsal vertebrae. Subsequently, the first one of them began to gradually change its identity, as can be observed in the slightly younger *Proganochelys quenstedti* from Germany, and eventually was freed from the carapace and lost its ribs. The morphologies observed in the Late Triassic turtles agree with results obtained experimentally during studies on the function of Hox homeotic genes, which are responsible for the body patterning and determination of axial identity. The gradual change of the identity of the eighth presacral vertebra in early turtles was most likely caused by the posterior shift of Hox-6 genes' expression range. These genes are responsible for determination of the cervicothoracic frontier in vertebrates. This explains several turtle-only oddities (e.g., why the brachial plexus and the scapula-building somites are restricted to the cervical region) and is congruent with phylogeny.

ID 157

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Turtles and *Eunotosaurus africanus* – Ancestry or Homoplasy?

Oral Presentation, Student Contribution

A set of 92 phylogenetic analyses reveals an apparent conflict in phylogenetic signal between the Ladinian stem turtle *Pappochelys rosinae* and the supposed Permian stem turtle *Eunotosaurus africanus*. Each of these two taxa, when tested individually, is well-supported as the sister group to turtles (bootstrap up to 74 for *E. africanus* and 83 for *Pa. rosinae*). When included together, however, the supports fall noticeably (bootstrap ≤62 for *Pa. rosinae* and ≤29 for *E. africanus*) and are even lower when the Middle Triassic parareptile *Candelaria barbouri* is included. Surprisingly, *E. africanus* shows affinity only with more advanced pantestudinates – removal of *Odontochelys semitestacea* (Carnian stem turtle) and *Proganochelys quenstedti* (Norian turtle) from the matrix results in exclusion of *E. africanus* from Diapsida, while *Pa. rosinae* retains its diapsid position. *E. africanus* is also located outside of Diapsida when *Pa. rosinae* is removed as well. Implied weighting increase the support for *Pa. rosinae* (bootstrap ≤71) but dramatically decrease the support for *E. africanus* (bootstrap ≤17). Examination of the lists of apomorphies for each of the analyses indicate that the turtle-*Eunotosaurus* clade is supported only by four characters (1,44% of all characters in the matrix), all localised within the trunk and correlated with recently proposed fossorial ecology of *E. africanus*. With implied weighting on, removal of only two of these characters causes the turtle-*Eunotosaurus* clade to lose all its support. No cranial characters explicitly support the turtle-*Eunotosaurus* relationships. This strongly suggest convergence rather than ancestor-descendant relationship between these taxa, contrary to recent reports.

ID 158

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A New Pancryptodiran Turtle from the Late Jurassic of Poland and the Evolution of Durophagy in Turtles

Oral Presentation

The Late Jurassic (Tithonian) lagoonal assemblage of Owadów-Brzezinki Fossilagerstätte (central Poland) yielded remains of *Owadowia borsukbiallynickae*, a new species of pancryptodiran turtle. The most diagnostic specimen, a partial mandible, is unique in its flat, expanded triturating surface of the symphyseal area. This morphology is interpreted as an evidence of durophagy. The way the triturating surface is extended, by posterior expansion of the symphyseal area but not medial expansion of the lingual ridges, was not reported in any other Jurassic turtle and thus is unique to the new taxon. It resembles, however, the morphologies observed in some protostegids and cheloniids, suggesting a similar trophic niche. The adaptation to durophagy (unheard of in terrestrial turtles) and the exceptional preservation of the bones (indicating little to no post-mortem transport) imply that *Owadowia borsukbiallynickae* was autochthonous to the lagoons of Jurassic Owadów-Brzezinki area and most likely fed on crustaceans or molluscs that were common there. This is the third finding of Jurassic turtle fossils in Poland, and the first specifically diagnostic. Turtles are rare in the Jurassic sediments east of Germany, and the context of unique, boreally-influenced paleoenvironment of Owadów-Brzezinki lagoons makes the new taxon even more exceptional.

ID 251

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***Hippopotamodon erymanthus* (Suidae, Mammalia) from Karabeyli, Uşak-Güre Basin, Turkey**

Poster Presentation

Uşak - Karabeyli, which is the name of the rich fossil mammalian locality was discovered in the Late Miocene Asartepe formation near the town of Uşak, Western Anatolia during late 1990's. The preliminary faunal list comprises 7 genus and species of: AVES: *Struthio*; CARNIVORA: *Ictitherium* cf. *viverrinum*; PROBOSCIDEA: *Choerolophodon* sp.; PERISSODACTYLA: *Hipparion* sp. (small form), *Hipparion* sp. (large form); ARTIODACTYLA: *Samotherium* sp., *Gazella* sp., *Protoryx* sp. The present study focuses on an suidae M3/s specimen which was not included to the former faunal list. The specimen is a slightly worn upper right M3 which has well-developed anterior and median accessory cusplets as well as pronounced talon cusp. In general view, the Karabeyli M3/ specimen is morphometrically and morphologically identical to *Hippopotamodon* (*Microstonyx*) which is a common element

of Late Miocene faunas of the SE Mediterranean region as well as Western and Central Asia. The metric comparisons differs Karabeyli *Hippopotamodon* (= *Microstonyx*) with the Vallesian forms while the morphology of the specimen is close to those of *Hippopotamodon erymanthus* that was recorded from Middle Turolian localities of Akkaşdağı (Turkey-MN12) and Samos (Greece-MN12). In conclusion, the characters and evolutionary trends of each faunal element, as well as the new Suid record indicates a Late Miocene age (Middle Turolian, MN12) for the fauna. Thanks to the new *Hippopotamodon erymanthus* record, paleoecological reconstruction based on the composition of the faunal community indicates a less open habitat by comparison with the previous study.

ID 127

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Cave Bear (*Ursus spelaeus*) Extinction in Northeastern Italy: Anthropic Impact, Stable Isotope Evidence and Extinction Chronology

Oral Presentation, Student Contribution
Symposium: Recent Advances on the Palaeoecology,
Evolution and Extinction of the Cave Bear

The cave bear (*Ursus spelaeus*) was one of many spectacular megafaunal species that became extinct during the last 30,000 years in Europe. The largest amount of remains has been recovered from many cave, most of which associated with human deposits in archaeological sites. In order to address the reasons for extinction and paleoecology of cave bears, we present taphonomic and isotopic analyses of Upper Pleistocene *Ursus spelaeus* (26-18 ka BP) from three cave sites in northeastern Italy (Vicenza): Grotta di Paina, Buso doppio del Broion and Covolo fortificato di Trene. In some of these caves, taphonomic analyses suggest close interactions between humans and bears. Numerous bear remains preserved traces of human modification such as cut marks, which enable a reconstruction of the main steps of fur recovery and the butchering process. In preparation of isotopic analyses, 49 cave bear bones were screened for collagen preservation by measuring their nitrogen content. The results demonstrated the very good quality of collagen preservation. The carbon and nitrogen isotopic analysis of this bone collagen will allow a palaeodietary reconstruction

of these cave bears, as well as direct radiocarbon dating. The broad range of plant types available and the favorable location of Berici Hills may have played an important role in the range expansion of cave bears and their interaction with the Paleolithic hunters who frequented the area.

ID 230

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Characterizing Dental Tools Using 3D Dental Topography and 'Network Indexes'

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy in Vertebrate Palaeontology

Challenging food properties may exert a strong selective pressure on vertebrates' dental morphology. Conversely, teeth can be used as 'dental tools' to ingest, reduce or fragment challenging food. A tooth can be a whole dental tool by itself or be composed of several dental tools, e.g. tribosphenic molars of mammals. Historically, dental tools have been characterized either in qualitative terms (blunt cusps, sharp crests etc.) or with metric measurements (shearing quotients). More recently, morphology of the whole tooth crown have been characterized using 3D dental topography, a computer-assisted method that considers the occlusal surface as a 3D polygonal mesh. Characterizing the topography of dental tools instead of the whole dental surface could help to investigate dental adaptations to challenging food, especially in extinct species whose morphology have no equivalent in extant species. Still an objective, non-manual method to separate dental tools from the whole crown remains to be developed. Here I propose to use three topographic variables as 'network indexes', a concept derived from traditional topography. Polygon elevation is used to separate cusp tip from valleys, mean curvature between adjacent polygons is used to separate sharp structures from dull ones, and polygon orientation is used to identify patches of buccal, lingual, mesial and distal orientation. Using different combinations of these three variables as 'network indexes', dental tools could be characterized in the upper molars of five far-related primates, selected for their contrasting occlusal morphologies.

ID 268

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New Aamynodontidae (Mammalia, Perissodactyla) From the Eocene-Oligocene of Romania

Oral Presentation

Perissodactyls are one of the major groups affected by the Grande Coupure event (Eocene-Oligocene transition) in Europe. Palaeotheriidae went almost extinct during this crisis, whereas Rhinocerotidae appeared for the first time in Europe after this biogeographical event. Knowledge on fossiliferous Eastern-European localities around this period is crucial for the understanding of this crisis. The recent re-discovery of the sedimentary block belonging to the type mandible of the Romanian Aamynodontidae (Rhinocerotidae) '*Cadurcodon*' *zimborensis*, as well as the fine preparation of the skull belonging to the same individual, allows assigning the proper locality to this remarkable material. It comes from Dôbarca (Sibiu County, Transylvania), of probable Late Eocene or Early Oligocene age, and not from Zimbor as previously thought. European Aamynodontidae are very rare, and exclusively belong to a single post-Grande Coupure genus (*Cadurcotherium*) from the Oligocene, but this skull clearly belongs to a new genus, characterized by an extraordinary growth of the nuchal crest. Along with this exceptional material, one aamynodontid tooth row (M1-M3) from another Romanian locality (Morlaca, Cluj County) has been recently discovered, and can be dated from the Late Eocene. It is clearly different from the material of Dôbarca and probably belongs to a new taxon close to the North American *Aamynodontopsis*. It represents the earliest occurrence of Rhinocerotidae in Europe, and is probably one of the 'precursors' of the Grande Coupure event. New phylogenetic hypotheses of Aamynodontidae, including this new material, are discussed and evidences show that they are closer to 'Hyracodontidae' than to Rhinocerotidae.

ID 224

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An Eocene Stem Testudinoid Turtle From Shandong Province, China

Oral Presentation

Testudinoidea is the most diverse group of living turtles, representing about half of the diversity of the order Testudines today. Known since the mid Cretaceous, the early stages of the radiation in this group remain largely unknown; and the pre-Eocene fossil record is exclusively found in Asia, suggesting that they originated in this region during the Cretaceous. All pre-Eocene stem testudinoid turtles have been assigned to the paraphyletic (or polyphyletic) Lindholmemydidae. This composite assemblage is characterized by a set of primitive characters, notably the presence of well-developed inframarginal rows makes them unique by comparison with the modern families. To date, none of these stem testudinoids has been reported after the Paleocene/Eocene boundary, suggesting that the stem testudinoids went to extinction before that time. Here we report the first post-Palaeocene stem testudinoid turtles from the early Eocene of Wutu, Shandong Province, China. This turtle with a full row of well-developed inframarginal scutes represents a relict taxon of stem testudinoids which survived after the Paleocene/Eocene boundary, as some mammals from the same locality. The first comprehensive phylogenetic analysis on the stem and modern testudinoids demonstrates that the stem testudinoids, previously placed in the family 'Lindholmemydidae' do not form a monophyletic group and the two major clades of testudinoids (Emydidae and Geoemydidae+Testudinidae) split one from another well before the Palaeocene-Eocene boundary, prior to the Late Cretaceous.

ID 164

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Identification and Stable Isotope Analysis of Theropod Teeth from the Kem Kem Beds: Explaining the Overabundance of Large Predatory Dinosaurs

Poster Presentation

Isolated theropod teeth from the Kem Kem Beds indicate a diverse array of predatory dinosaurs during the Albian-Cenomanian of North Africa. Stable oxygen isotopes in the teeth are used to find an explanation for the overabundance of theropods by yielding information on palaeoenvironment and palaeobiology. Enamel has a dense crystalline structure and therefore is very resistant to post-depositional modification, preserving the stable oxygen isotope ratios throughout geological time. Four *Spinosaurus* and four *Carcharodontosaurus* teeth were selected for stable oxygen isotope analysis of the enamel. Serial sampling of the larger teeth, and bulk sampling of the smaller teeth, supplied enamel powder that was processed for stable oxygen isotope analysis. Fluctuations in $\delta^{18}\text{O}$ along the growth axis of the larger *Spinosaurus* and *Carcharodontosaurus* teeth suggest seasonal variation in the palaeoclimate. Lower $\delta^{18}\text{O}$ values of the tooth enamel from *Spinosaurus* compared to *Carcharodontosaurus* are interpreted as a more aquatic lifestyle for the former, providing an explanation for the coexistence of the large theropods.

ID 195

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Neutron-Based Computed Microtomography: *Pliobates cataloniae* and *Barberapithecus huerzeleri* as a Test-Case Study

Oral Presentation

Constant improvements in image detectors and computing power have enabled high-resolution imaging with X-ray tube and synchrotron radiation microtomography (μ CT) of sediment-embedded fossils. Although this represents a powerful tool for anatomical analysis, bone and dental tissues do not always provide a distinct structural signal with X-rays. Here we compare the results of neutron μ CT scans performed at the ANTARES facilities of the FRM II research reactor in Munich with standard X-ray μ CT scans for several fossil remains. In particular, we scanned fossils of two Miocene catarrhines from the Vallès-Penedès Basin that had been previously proven problematic with X-rays: the holotype skull (IPS58443) of the stem hominoid *Pliobates cataloniae*; and three lower molars (IPS1724m,n,o) from the holotype of the pliopithecoid *Barberapithecus huerzeleri*. X-ray-based μ CT for these specimens failed to retrieve any contrast between the fossil tissue components (i.e., the normal distribution of the contrast histogram was shifted to the low or high end of the curve). This is due to the extreme similarity between the chemical composition of the embedding matrix and fossil in IPS58443 and to the presence of high-density elements in IPS1724. In contrast, neutron-based μ CT delivered high-contrast images of the studied specimens. In fact, neutron radiation easily penetrates metals and may return very different contrasts of different isotopes of the same element, thereby enabling a correct definition of the bone-sediment interface and a proper segmentation of the images stack. In conclusion,

neutron-based μ CT represents a viable alternative to X-rays for the extraction of anatomical information from problematic samples.

ID 181

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Preliminary Approximation on the Locomotion and Body Mass of Giant Mustelids and Other Musteloids (Ailuridae and Procyonidae) Throughout the Neogene and Quaternary

Oral Presentation

Symposium: Ecomorphology and Functional Anatomy in Vertebrate Palaeontology

Mustelids represent the most diverse living family of Carnivora, displaying a broad range of locomotor behaviors, including terrestrial, semi-fossorial, scansorial, arboreal and semi-aquatic. Moreover, mustelid body mass (BM) ranges between the 0.025 kg (*Mustela nivalis*) and 45 kg (*Enhydra lutris*), spanning three orders of magnitude. We analyzed 14 linear measurements from humerus, radius, ulna, femur and tibia of a living sample of 192 specimens of carnivorans to evaluate the locomotion and BM of a sample of extinct Neogene and Quaternary large mustelids, procyonids and ailurids. The predictive equations generated based on postcranial remains indicate that the largest extinct mustelid could weigh more than 200 kg, which means four orders of magnitude in BM for the whole family. These predictive equations allow us to propose an updated definition for giant musteloids, including giant mustelids, ailurids and procyonids. Gigantism in mustelids appears early in their evolutionary history, as observed in several independent radiations in North America, Eurasia and Africa throughout the Neogene and Quaternary. This gigantism is also present in other musteloids as ailurids and procyonids. Our research shows that several unique ecomorphotypes of giant musteloids evolved in the Neogene that are different from any living carnivorans, such as a Puma-sized oligobunine with terrestrial and semifossorial traits, *Megalictis ferox*, wolf to leopard-sized mellivorines with hypercarnivorous dentitions and terrestrial and cursorial traits (*Ekorus ekakeran* and *Eomellivora piveteaui*) or black bear-sized otters (Enhydriodontini), that were somewhat more terrestrial than living otters.

ID 135

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An Overview of the Life History and Growth of Cave Bears

*Oral Presentation**Symposium: Recent Advances on the Palaeoecology,
Evolution and Extinction of the Cave Bear*

Cave bears are uniquely suited for studies of development due to their abundance in the fossil record and the existence of exceptionally well preserved neonates, which has led to speculations on the ontogeny of these animals in past work. The comprehensive work of Ehrenberg on the material from the Drachenhöhle/Mixnitz included hypotheses on cave bear development. He proposed that the development of the cave bear skulls follows a growth trajectory from a perceived primitive brown bear condition, over a Deninger bear condition, to the adult condition. Recent morphometric studies show that even in early development cave bear skulls are distinct in their shape from brown bear juveniles. Ehrenberg also proposed that the birth weight of cave bears was small and to reach adult size cave bears grew faster than extant brown bears. The speed of growth is essential in understanding the development of an animal as many life history events are correlated with it. An overview on concepts around the ontogeny of cave bears shows that many life history events are difficult to reconstruct. Studies on postcranial growth often use estimated age for juvenile individuals based on tooth eruption stages, with brown bears as reference. However, the time and sequence of tooth eruption can be different among bear species. Based on a review of data on skull growth, palaeohistology, and inferences drawn by studies of brain size, we present hypotheses on some life history patterns and on growth patterns in cave bears in comparison with its closest living relatives.

ID 138

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'Resurrecting' Darwin's Extinct Niata Cow - An Anatomical, Biomechanical, Genetic, and Morphometric Study of Morphological Novelty in Cattle

Oral Presentation

Extinction is not only a feature of life in geological time but also is part of the history of domestication of many species. A cattle variety from South America, the Niata, is an example of particular morphological and historical interest. It figured prominently in writings on evolution by Charles Darwin. Its brachycephalic head and other aspects of its morphology have been subject of discussions and speculation. We examined the anatomy, cranial shape, skull biomechanics, and genetic diversity of the Niata among other cattle breeds as an example of the evolution of morphological disparity during domestication. The Niata was a viable and distinct variety of cattle. Its external suture obliteration pattern is different from the one in lethal forms of chondrodysplasia. In morphospace, the Niata occupies an isolated position clearly separated from other cattle breeds. The much derived skull configuration has influenced stress distribution while feeding, making the skull of the Niata better suited for processing plant matter. SNP data shows that the Niata is also genetically distinct from other cattle breeds. Morphological and genetic data illustrate the acquisition of novelty in the domestication process and confirm the distinct nature of the Niata cattle validating Darwin's view that the Niata was a true breed.

ID 187

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Proteid Salamanders (Salamandroidea, Proteidae) from the Early Oligocene of Romania

Poster Presentation

The proteids represent a small group of perennibranchiate salamandroids with a known fossil record from the Late Cretaceous and late Palaeocene of North America, late Oligocene and Miocene of Asia, Neogene and Quaternary of Europe. Here, we report the geologically oldest (early Oligocene) proteid fossils from Eurasia. The new specimens (isolated jaw bones and vertebrae) from Cetățuia Hill, Cluj-Napoca and Suceag (MP 23-24) appear closely allied with *Mioproteus caucasicus* and *M. wezei* with a number of synapomorphies on the vertebrae and jaws representing probably a basal member within the genus *Mioproteus*. Peculiarly, the proteid remains from the early Oligocene locality of Suceag 1, were accompanied by the palaeobatrachid frog *Albionbatrachus*, a form

closely linked to aquatic environments and with a rather limited fossil record in the Palaeogene (i.e. late Eocene of southern England, early Oligocene of Romania and late Oligocene of Germany). Their associated presence may suggest that in the early Oligocene dispersal of European proteids occurred through the same freshwater corridor as that of *Albionbatrachus* being directed from northwestern European territories into southeastern territories, rather than from east to west (i.e. from Asia into Europe), as it has been suggested recently.

ID 121

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Southern Germany: An Early to Middle Miocene Lizard Melting Pot?

Oral Presentation

The Miocene of Southern Germany is particularly rich of localities having yielded remains of lizards. A survey of fossils collected from some of these sites and now stored in the Bayerische Staatssammlung für Paläontologie und Historische Geologie in Munich (Gisseltshausen 1a and 1b, MN 5 [1]; Griesbeckerzell 1a, MN 6 [2]; Kleinenbach, MN 8 [3]; Stubersheim 2 and 3, MN 3 [4]) has revealed a rather high diversity of the lizard assemblage from the early and middle Miocene of the region. On the whole, identified taxa include Chamaeleonidae indet. [1], Gekkonidae indet. [1,3], *Edlartetia* cf. *E. sansaniensis* [3], cf. *Edlartetia* sp. [4], *Janosikia ulmensis* [1,2], *Mediolacerta* sp. [4], cf. *Miolacerta* sp. [1,3], *Edlartetia* sp. vel *Miolacerta* sp. [2], Lacertidae indet. [1,2,3,4], ?Lacertidae indet. [4], aff. *Eumeces* sp. [1,4], Scincidae indet. [1], *Anguis* sp. [2], *Ophisaurus holeci* [4], *Ophisaurus* sp. [1,2,3,4], *Pseudopus laurillardi* [2], cf. *Pseudopus laurillardi* [1], *Pseudopus* sp. [1,2,3,4], *Merkurosaurus* sp. [4], Varanidae indet. [3], cf. *Blanus* sp. [3] and Amphisbaenia indet. [1,2,4]. These add to *Chamaeleo caroli* [4], *Ophisaurus feffari*, *Blanus antiquus* and *Palaeoblanus tobieni*, previously reported from these localities. The assemblage figures as a mix of components having either Western (*Edlartetia*, *Mediolacerta*) or Eastern (*Miolacerta*, *O. holeci*, *Merkurosaurus*) European affinities, but it also presents its peculiar taxa (e.g., *J. ulmensis*). The rare findings of teeth closely resembling those of extant African skinks, currently unknown in other Neogene European localities outside Southern Germany, is also intriguing.

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ID 229

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First Record of *Latonia gigantea* (Anura, Alytidae) From the Iberian Peninsula

Poster Presentation

The single extant species of *Latonia* lives in Israel, but in the fossil record the genus is known mainly from Europe, spanning from the Oligocene to the Early Pleistocene. During the Miocene, the genus was widespread all over the continent, being represented by four species. Here we report new remains of *Latonia* from the early to late Miocene (MN4 to MN9) of the Vallès-Penedès Basin (NE Iberian Peninsula). Fossils from the late Aragonian and early Vallesian are attributed to *Latonia gigantea* mainly because of the morphology of the ornamentation that covers the maxillae. In turn, an ilium from Sant Mamet (MN4) is not diagnostic at the species rank and is therefore assigned only to the genus *Latonia*. The newly reported remains represent the first record of *L. gigantea* in the Iberian Peninsula, where *Latonia* was previously known by a single report of *Latonia* cf. *ragei* from Navarrete del Río (Teruel, MN2) and remains from other localities unassigned to species. Moreover, the Vallès-Penedès remains represent one of the southernmost records of the species known thus far. The presence of *Latonia* in these localities confirms the humid and warm environment suggested by the recorded mammal fauna. The extant *Latonia nigriventer* lives in a marshy area, but it is unclear whether extinct species of the genus had the same ecological requirements or displayed a wider range of habitat preferences (as most of the extant discoglossines).

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ID 115

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Early Miocene Chondrichthyes from Chile: Paleobiogeographic and Ecological Implications

Poster Presentation

The early Miocene is characterized by warm conditions until the middle Miocene when temperatures dropped significantly. The presence of tropical to subtropical invertebrate faunas in early Miocene sediments of Chile supports the hypothesis of warm temperatures. The Neogene fossil record of chondrichthyes has been well established for Chile. However, most studies focused on middle Miocene to Pliocene records, whereas early Miocene chondrichthyes have been rather poorly investigated up to now. The aim of this study is to describe early Miocene chondrichthyes from Chile and to discuss their paleobiogeographic and ecological implications. Here, we report seventeen chondrichthyan taxa for the early Miocene of Chile: *Callorhynchus* aff. *regulbiensis*, *Carcharoides totuserratus*, *Carcharoides* sp., *Isurus* cf. *oxyrinchus*, *Carcharias* cf. *cuspidata*, *Odontaspis ferox*, *Megascyliorhinus trelewensis*, *Galeorhinus* sp., *Mustelus* sp., *Squatina* sp., *Pristiophorus* sp., *Squalus* sp.1, *Squalus* sp.2, *Heterodontus* sp., *Dasyatidae* indet.1, *Dasyatidae* indet.2 and *Myliobatis* sp. The fauna includes the first fossil record of *Mustelus* from the Pacific coast of South America, the oldest record of *Galeorhinus* for South America, and the first oral tooth of *Pristiophorus* from the Neogene of South America. Our results show that six of 18 taxa present during the early Miocene went globally extinct (33%). At the same time, we identify dramatic biogeographic changes (i.e. decrease or increase of latitudinal ranges) from the early Miocene to the present. The complete extirpation and the latitudinal changes observed in chondrichthyes can best be explained by the climatic fluctuations during the Neogene and Holocene along the Pacific coast of South America.

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ID 276

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Evidence for Active Flight in *Archaeopteryx*

Oral Presentation, Student Presentation

Although recent decades have seen an exceptional wealth of new discoveries that have refined our understanding of the origin and early evolution of birds, the deep phylogenetic position of the long-known stem bird *Archaeopteryx* from the Late Jurassic of Bavaria consolidated its status as a crucial taxon for illuminating the early evolution of avian flight. Nevertheless, the locomotory abilities of many early birds have proven challenging to reconstruct. Despite suggestions that *Archaeopteryx* may have been capable of active volancy, several aspects of its reconstructed pectoral morphology are inconsistent with the execution of the modern avian flight stroke. In order to gain insight into the function of the putative flight apparatus in *Archaeopteryx*, three specimens were subjected to propagation phase contrast synchrotron radiation micro-computed tomography (PPC-SR μ CT) on beamlines BM05 and ID19 at the ESRF in Grenoble, France. Mid-diaphyseal cross sections of their humeri and ulnae were visualised and compared with those of an archosaurian reference sample spanning a wide range of locomotory strategies. Statistical comparison revealed a strong affinity with volant birds, particularly with those that employ wing flapping to engage in short-distance aerial excursions. To unify this outcome with the established arguments against flapping flight in *Archaeopteryx*, we present a novel flight model that may have allowed for aerial excursions through wing mobility consistent with its skeletal architecture. The early development of avian flight included alternative modes of aerial locomotion with respect to those persisting in modern birds that were outcompeted by more successful flight strategies during the Cretaceous.

ID 284

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A Rhabdodontid Dinosaur Skeleton From the Uppermost Campanian/Lowermost Maastrichtian of Sebes (Transylvanian Basin)

Oral Presentation

The Transylvanian region of Romania boasts a rich fossil record of dinosaurs, which lived on an island during the end-Cretaceous. Many of these were dwarfed or exhibited

other unusual features thought to be linked to their insular habitat. The most common of these dinosaurs is the rhabdodontid *Zalmoxes*, a herbivorous taxon that has been found at many Upper Cretaceous sites across Transylvania. In the Sebes area, rhabdodontid fossils are recorded in many localities, stratigraphically covering a long time span, from the late Campanian to the latest Maastrichtian. Most fossils are represented by isolated bones, whereas associated or partial skeletons are exceedingly rare, more common in the lower section of the Sebes Formation, of early Maastrichtian age. The best dated vertebrate locality is Petresti-Arini that exhibits a continuous section of upper Campanian-lowermost Maastrichtian marine, bish and continental deposits. Here, disarticulated rhabdodontid remains were previously recorded from marine-coastal and fluvial facieses, most too fragmentary to allow precise taxonomic identification. One remarkable exception is represented by a fully-articulated, complete skeleton, recovered from a reddish claystone floodplain unit. This specimen shows perfect 3D preservation, with possible soft-tissue fossilization (tendons, cartilages). Based on preliminary taphonomic and sedimentologic analyses, the carcass was dried/mummified, then buried in mud during a flood event. This specimen allows for the first time an accurate size, proportions and body-posture reconstruction, and morpho-functional interpretation of the Transylvanian rhabdodontids.

ID 133

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A New Placodont Specimen from the Early Late Triassic in Southwest China with Affinities to the European *Cyamodus*

Oral Presentation, Student Contribution

Triassic eastern Tethyan faunas in southwest China continuously yield numerous marine reptile taxa in recent years. Nevertheless, compared with other sauropterygian lineages, the diversity of placodonts is relatively lower with rarer preservations in fossil assemblages. Here, we report a new cyamodontoid specimen, ZMNH M8820, from the early Late Triassic in Guizhou, China. This specimen is an almost complete skeleton which lacks the forelimbs, and which is distinct from other known Chinese placodonts based on, among other features, extremely round orbits, a remarkable enlarged supratemporal fenestra, and less

regular carapacial configuration. Interestingly, this new specimen resembles the European *Cyamodus* more than any other Chinese cyamodontoid genus, particularly based on the dentition and other cranial anatomical characteristics. It still differs from other *Cyamodus* species by possessing a disproportionately small carapace bordered by a smooth lateral margin and the absence of a sacral shield. Furthermore, our preliminary phylogenetic results showed affinity to *Cyamodus* species of this new Chinese specimen. The analysis based on placodont cranial characters indicates a sister-group relationship between ZMNH M8820 and *C. kuhnschnyderi*, both as the most derived members nested in a monophyletic group of all *Cyamodus* species. Another analysis using a larger matrix of diapsid reptiles merely shows an unsolved polytomy of ZMNH M8820, *Cyamodus* and *Sinocyamodus*. Although the existence of a potential *Cyamodus* species in southwest China positively reveals more resemblance between western and eastern Tethyan marine reptile faunas, the palaeobiogeographical origin and migration history of Cyamodontidae or even any other clades of placodont reptiles are still obscure.

ID 109

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The Eocene Vertebrate Fossils in the Geiseltal Collection (Martin Luther University, Halle-Wittenberg, Germany)

Oral Presentation

The Geiseltal Collection at the Center for Natural Science Collections of MLU holds about 50,000 fossil specimens, of which more than half are vertebrates. The entire collection is protected as national heritage, containing nearly every animal fossil from the nearby Geiseltal fossilagerstätte, excavated 1925-2003. More than two dozen taxa were named from the site. Formed in peat bog by calcium-carbonate-rich waters during subtropical climate, fossil preservation is truly excellent: often articulated and three dimensional, with soft tissue, color, and even cellular preservation. Geiseltal deposits are dated to ~47.5–42.5 million years (MP 11–14); far exceeding in range other Eocene sites in Germany. Rare fossil fish include 'Amiidae', Lepisosteidae, Thaumaturidae, and Percidae. Amphibians include six frog taxa and at least two taxa of salamanders. The turtle fauna consists of testudinids as well as freshwater geomeydids and softshell turtles. Lizards include the anguine *Ophisauriscus*, the iguanian *Geiseltaliellus*, the relict *Eolacerta*, and the 'necrosaurid' *Eosaniwa*. Two types of boas and one aniliid species are known. Five crocodilian species (*Diplocynodon*, *Allognathosuchus*, *Bergisuchus*, *Asiatosuchus* and *Boverisuchus*) reveal at least

four sympatric taxa. Birds include the giant *Gastornis*, the ostrich-like *Palaeotis*, and a dozen additional genera. Among the 76 mammal taxa are the marsupial *Amphiperatherium*, primates (including *Europolemur*), creodonts, early insectivores & bats, the pangolin *Eurotamandua*, rodents, a tilodontian, and many ungulates. Among the latter are ancient horses (*Eurohippus*, *Propalaeotherium*, *Hallensia*), the tapir-like *Lophiodon*, and *Hyrachyus*. The tantalizing collection has high potential for modern studies (CT-based research, geochemistry, paleoclimate, and paleoecology) and we expect upcoming thriving research.

ID 183

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Hydrodynamic Investigation of Swimming Behavior of a Middle Jurassic Plesiosaur and a Recent Sea Turtle Using Computational Fluid Dynamics Software

Oral Presentation

Plesiosaurs were globally distributed, highly aquatic marine diapsids that had evolved a unique locomotory apparatus with four hydrofoil-shaped flippers. Over 135 Ma of evolution, this locomotor design experienced only minor structural changes. Virtual hydrodynamic analysis of underwater flight started with measuring of a specimen of the Middle Jurassic plesiosaur *Cryptocleidus eurymerus* from England on exhibit at the Goldfuß Museum (University of Bonn, Germany) for reconstruction of the complete body as a finite element model. A reconstruction of a recent underwater flyer, *Caretta caretta* (Cheloniidae), dissected at the Stazione Zoologica Anton Dohrn Napoli, Italy, was used as an anatomical and functional analog. The dissection gave important insights into locomotor muscles, lines of action and cross sectional areas of these muscles, maximum muscle forces, and flipper profiles. For plesiosaur and sea turtle alike, pairs of agonistic and antagonistic muscles were identified for the main phases of the limb motion cycle. Finite element models for both, the plesiosaur and the turtle, were studied in a virtual flume with different flow velocities to simulate different flight speeds, enabling us to determine drag, lift, and propulsion of the flipper using finite element-computational fluid dynamics software. In the virtual flume, every profile along the flipper length has optimal angles of attack and angles of flipper twisting. At a flight speed of, e.g., 2 m/s, *Caretta caretta* drag peaks at 29 N and maximal propulsion at 67.8 N; *Cryptocleidus eurymerus* drag peaks at 55.4 N, and maximal propulsion generated by one foreflipper reaches 404 N.

ID 116

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New Giraffids (Mammalia, Artiodactyla) from the Upper Miocene of Thermopigi (Macedonia, Greece)

Poster Presentation, Student Contribution

The fossiliferous site of Thermopigi (Central Macedonia, N. Greece) is known to palaeontologists for the past 18 years. After the first field campaigns a wealth of new information on the overall geology, taphonomy and palaeontology of the site became available. With more than 1300 fossils excavated so far, Thermopigi can be considered a rich Late Miocene locality, with hipparions, bovids, giraffes and rhinos being the most prominent representatives of this fauna. Based on the preliminary study of Thermopigi's fossil fauna, the presence of at least 20 mammalian species can be concluded. The equids dominate the assemblage with 52%, while giraffids are only about 5%, with 53 recovered and identified specimens. Four different giraffid species have been identified: *Samotherium major*, *Helladotherium duvernoyi*, *Palaeotragus rouenii* and a new palaeotragine, *Palaeotragus* sp. nov. The assemblage reveals the northernmost occurrence of *Samotherium major* and the second recorded presence of the species on the terrestrial greek terrain. *Helladotherium duvernoyi* is the most abundant giraffid in Thermopigi, with the largest collection of fossils containing both dental and skeletal elements. The comparison of the specimens of *Palaeotragus* sp. nov. with other palaeotragine giraffids confirmed the coexistence of two *Palaeotragus* taxa, one slightly larger than the other. According to the above-mentioned data and taking into consideration the big abundance of *H. duvernoyi*, the presence of *S. major* and moreover the coexistence of the latter with *P. rouenii* and a slightly larger palaeotragine, *Palaeotragus* sp. nov., it is concluded that Thermopigi is a middle Turolian site (MN12).

ID 272

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First Record of *Hystrix* (Mammalia, Rodentia) from the Çorakyerler (Çankırı – Central Anatolia) Fauna (Early Tu- rolian, MN11)

Poster Presentation

Çorakyerler Hominoid Site preserves exceptional fossil material of Anatolian Late Miocene since the beginning of 2000. Besides its unique hominoid record, the characterizing taxa for Çorakyerler include also a large component of bovids, as well as diverse carnivores, equids and giraffids. The micromammal fauna of Çorakyerler has received relatively little attention in the past. The single study had reported 12 species, two of which were new: *Byzantinia pikermiensis*; *Allocrietus aylasevimae* n. sp, etc. Here, we present the preliminary results of a new addition to Çorakyerler micromammal fauna, the first specimen belonging to large size rodents of Hystricidae, known as porcupines. Though the porcupine records from Anatolia during Late Miocene is very limited, there are still described specimens represented with *Hystrix primigenia* (Muğla-Eski Bayırköy –MN12; Çanakkale-Gülpınar MN12; Muğla-Şerefköy 1–MN12; Uşak-Kemiklitepe A/B(MN11/12) and with *H. depereti* (Çobanpınar, Sinap 42, MN12). The latest record belongs to the Nevşehir-Taşkınpaşa fauna which was described as *Hystrix* sp. The material announced here consists of right maxillary fragment with P4-M2. Although this preliminary study prevents definitive identification of the material, it fits well with the morphologic (rectangular occlusal outline) and metrical features (M1 longer than M2) characteristic of the medium sized Turolian species of *H. aryanensis* which was already been recorded in Iran (Ivand 1–M12) and Afganistan (Molayan–MN12). The scarcity of Late Miocene *Hystrix* remains in Turkey increases the importance of each new finding and the relevance of the information that they provide. Therefore, the new Çorakyerler specimen will help to clarify dispersal of porcupines during Late Miocene.

ID 163

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'Rediscovery' of the Allemann Vertebrate Collection from the Santa Cruz Formation (Late Early Miocene), Argenti- na at the Paleontological Museum, Zurich

Poster Presentation, Student Contribution

During most of the Cenozoic, South America was isolated and it was home of an endemic fauna which included giant sloths, glyptodonts and terror birds (phorusrhacids) among others. One of the most important faunal assemblages that characterize these past ecosystems comes from the Santa Cruz Formation (Santacrucian South American Land Mammal Age, 18.9-16.2 Ma, late early Miocene) in Patagonia, Argentina. Current curatorial efforts revealed a large collection (ca. 1000 specimens) of fossils from the Santa Cruz Formation, donated by the Olten Natural History Museum to the Paleontological Museum, University of Zurich in 2007. The fossils were collected in the late 1880s by Theodor Allemann, an engineer and amateur collector, who donated his collection in 1926 to Olten. The collection includes complete skulls, isolated teeth, mandibles and isolated postcranial elements. Postcranials are mainly represented by astragali, calcanei, and osteoderms. The systematic revision of the material allowed us to recognize eight lineages of mammals and one of birds: Astrapoteria (Astrapotheriidae), Cingulata (Chlamyphoridae), Litopterna (Macraucheniiidae, Proterotheriidae), Notoungulata (Interatheriidae, Toxodontidae), Paucituberculata (Caenolestidae), Pilosa (Mylodontidae), Rodentia (Acaremyidae, Chinchillidae, Dasyproctidae, Dinomyidae, Eocardiidae, Neoepiblemidae), Sparassodonta (Hathliacynidae) and Cariamiformes (Phorusrhacidae). We have identified 22 genera and 17 species. Reference to previous work on the Santa Cruz fauna and the good preservation of the material allow us to achieve taxonomic resolution in the identifications; using micro-CT scanning and paleohistological sampling, new data regarding the paleobiology of these animals are being analyzed.

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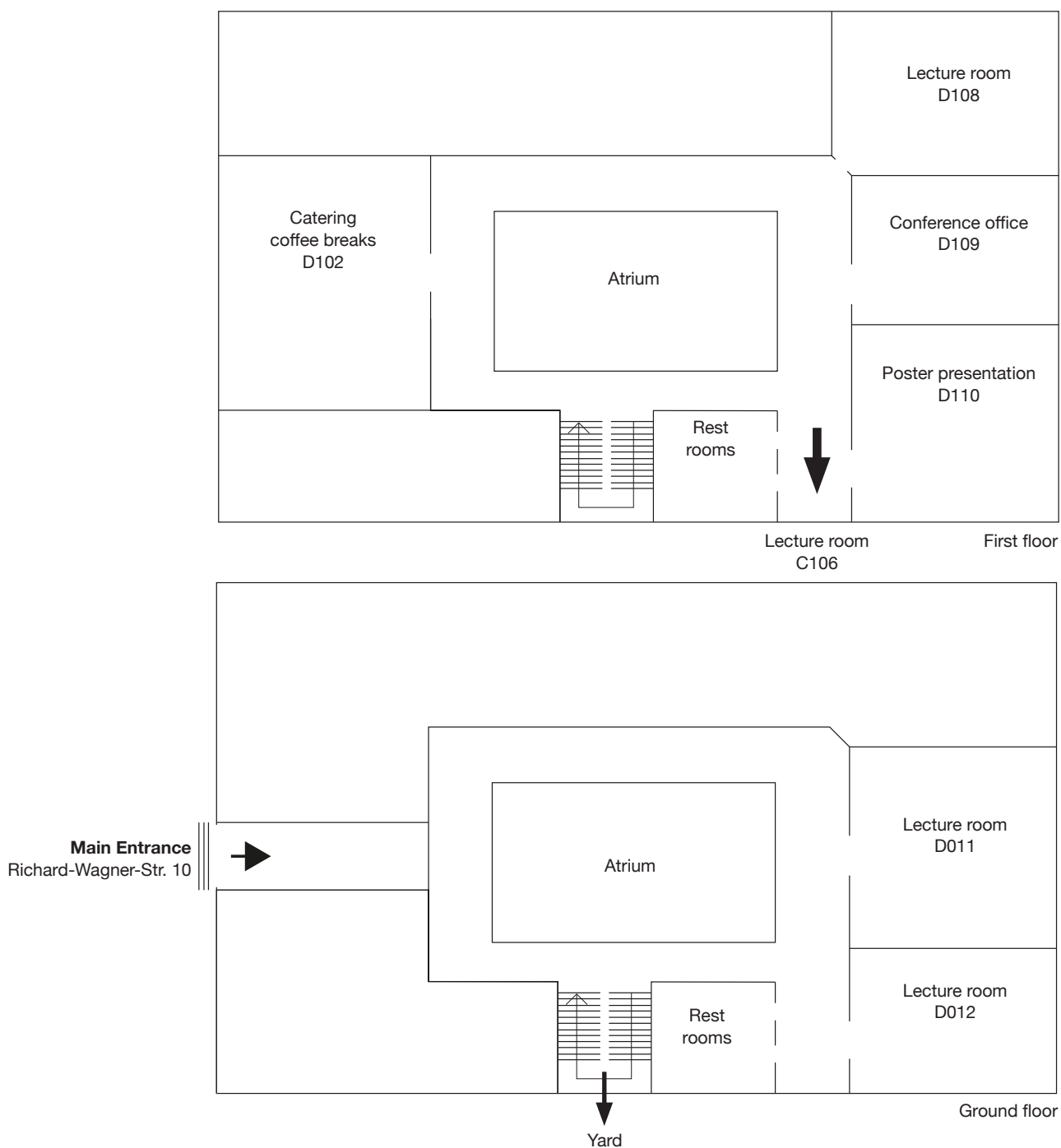
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Lecture Rooms, Opening Hours, Wi-Fi



Conference Office

Room D109

Opening hours:

Monday, 31st July 2017, 4pm to 8pm

Tuesday, 1st August 2017, 7:30am to 5pm

Wednesday, 2nd August 2017, 7:30am to 5pm

Thursday, 3rd August 2017, 7:30am to 5pm

Wi-Fi/WLAN Internet Access

Access open in rooms:

C106, D011, D012, D108, D109

Monday, 31st July 2017, 8am to 8pm

Tuesday, 1st August 2017, 8am to 8pm

Wednesday, 2nd August 2017, 8am to 8pm

Thursday, 3rd August 2017, 8am to 8pm

Notes
